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VOLUME XXIII

JANUARY TO DECEMBER, 1918

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Vol. XXIII — JANUARY, 1918 — No. 1

Stop Waste and Practice Self-Denial

"THIS war cannot be financed unless the American people immediately stop waste, practice self-denial, economize in every possible direction and lend the money they save thereby to the Government. . . . The widespread practice of economy is absolutely essential to the success of the war."—*Secretary of the Treasury McAdoo.*

To every American the recent issue of Government war saving stamps in denominations of 25 cents and $5 gives an opportunity such as has never before been offered for investing their savings with absolute safety and at attractive rates of interest. Everyone, however small his means, can help by investing in these war certificates. Every dollar thus saved will hasten the end of the devastating war in Europe.

Naval Expansion

SOME idea of the efficiency of the Navy Department and how it has met the extraordinary demands of the present war crisis can best be gained from the utterances of the Secretary of the Navy in his annual report and before the investigating committee of Congress. From a force of 4,500 officers and 68,000 men enlisted in January, 1917, the Navy has expanded to 15,000 officers and 254,000 enlisted men. Further expansions are inevitable. A year ago the Navy had 130 stations of all kinds; it has now 363. The number of employees at regular navy yards has increased from about 35,000 to over 60,000. On shore and afloat the naval establishment embraces more than 300,000. At the beginning of the fiscal year 1917 the monthly expenditures for all naval purposes were about $8,000,000 (£1,640,000); they are now about $60,000,000 (£12,300,000). A year ago there were 300 naval vessels of all kinds in commission; to-day there are considerably more than a thousand. These typical figures sufficiently indicate the task the Navy has had to accomplish in the way of expansion.

The ability of the Navy, without friction or hurrying, to bring to bear its military force rapidly and to increase it threefold in a short time, is credited by the Secretary of the Navy to the system that had been built up in peace times and to the securing before the war of a larger building programme extending over a term of years, as well as to the authorization of an increased personnel. Internally the efficient organization, working together for years as a trained team, made the Navy Department's rapid expansion easy, though it taxed the strength and energy of every department head and the entire personnel on shore and in the fleets. It goes without saying that such satisfactory progress in the fighting strength of the Navy could not have been accomplished without corresponding efficiency in the business affairs of the department, and it is largely due to the improved business methods and purchasing systems developed that the Navy Department has been able to meet the tremendous and sudden demands of war and embark upon such unprecedented programmes of construction and equipment without breaking down the business machinery of the department.

Secretary Daniels' message to the American people that "the Navy has met its duties of the present and is preparing for those of the future" will be received with confidence and no interference with the efficient work of this branch of the government will be tolerated.

Difficulties in Merchant Shipbuilding

UNLIKE the Navy Department, which had an experienced and efficient organization with which to carry forward its unprecedented expansion in recent months, the construction of the emergency fleet—a task of equal importance and of even greater magnitude—has been delegated ever since the work began to men with little or no experience or training in shipbuilding. The continued failure of the Shipping Board to make use in either executive or advisory capacities of the services of expert builders of merchant vessels is a policy for which no excuse can be offered. The frequent changes of personnel in both the Shipping Board and the Emergency Fleet Corporation, and the difficulties needlessly encountered in the early stages of the work, coupled with the lack of harmony between the government and the shipbuilders, are eloquent proof of a mistaken policy and one which the country has every reason to regret.

When all is said and done, however, the success or failure of the merchant shipbuilding programme will depend upon the securing of an adequate supply of experienced labor and competent shipyard organizations to direct it. Chairman Hurley acknowledges this and points out that the Emergency Fleet Corporation is at present controlling work in 132 shipyards, of which only 58 were in existence a year ago, while 74 are new plants. An encouraging indication of progress is found, however, in reports from 109 shipyards, which show that during the nine weeks beginning October 6 the number of employees has increased 45.2 percent.

Gross and Deadweight Tonnage

DUE to the fact that figures relating to the tonnage of merchant shipping building for the Shipping Board are given in deadweight tons, while the figures for vessels building in Great Britain, and as formerly given for the American merchant marine by the Bureau of Navigation, were in gross tons, much confusion has resulted in the minds of the public as to the comparative production of merchant vessels in this and other countries.

The gross tonnage of a vessel is an arbitrary figure

representing the volume of a certain portion of the internal capacity of a vessel, together with the volume of a portion of its erections expressed in tons of 100 cubic feet each. The net registered tonnage of a vessel is the gross tonnage reduced by an arbitrary amount of volume supposed to be devoted to the propelling machinery and of certain spaces devoted to the use of the crew. On the other hand, the deadweight tonnage of a vessel is the measure of a portion of the displacement to a certain draft available for the carriage of cargo, fuel, water, crew, stores, etc., expressed in tons of 2,240 pounds. In order to use deadweight tonnage as a fair method of comparison between vessels of the same type, it is necessary that the draft should be determined. This is done in Great Britain by the adoption of a table of freeboards which limits the draft for each particular vessel. Again, in figuring the deadweight tonnage sometimes the water in the boilers is excluded, while at other times the water is included.

The net tonnage is used by all the maritime nations of the world and is supposed to represent a measure of the earning capacity of the vessel. If deadweight tonnage were used, it would probably be also with the idea of representing the earning capacity of the vessel, but consideration of this question will show that the earning capacity of the vessel is sometimes dependent upon the cubic capacity available for cargo, sometimes upon the deadweight capacity available for cargo, sometimes upon the speed of the vessel, sometimes upon the amount of fuel that can be carried and sometimes upon the amount of space available for passengers. Comparative figures, therefore, should be examined with care, and consideration should be given to the conditions upon which they are based, as otherwise the figures will be misleading.

The Lighthouse Service

According to the annual report of the Commissioner of Lighthouses to the Secretary of Commerce for the fiscal year ended June 30, 1917, the United States Lighthouse Service maintains aids to navigation on all coasts under the jurisdiction of the United States, except the Philippine Islands and Panama, and also on the principal interior rivers. This Service is charged with the maintenance of aids to navigation along 47,192 statute miles of coast line and river channel. On June 30, 1917, there were 5,796 persons employed in the Lighthouse Service, including 122 technical force, 149 clerical force and 5,525 employees connected with depots, lighthouses and vessels. During the fiscal year there was a net increase of 275 in the total number of aids maintained, the total at the end of the year being 15,223. Of these 5,420 are lights of all classes and 588 are fog signals. The total number of aids in Alaska, comprising lights, fog signals, buoys and daymarks in commission at the close of the fiscal year was 416, including 159 lighted aids.

During the fiscal year 50 tenders and 68 light vessels were in commission. The new tenders *Palmetto* and *Cedar* were completed and immediately placed on duty. Two new light vessels were completed during the year; *No.* 101 off Cape Charles, entrance to Chesapeake Bay, Va., and *No.* 102 at Southwest Pass, entrance to Mississippi River, La. Light vessels *No.* 99 for relief duty on the Great Lakes is under construction.

During the fiscal year 1917 services in saving life and property were rendered and acts of heroism performed by employees of the Lighthouse Service on 160 occasions. Recommendation is renewed for legislation authorizing the retirement of employees of the Lighthouse Service on account of age or disability incident to their work, which is the practice of the lighthouse services of many other countries. A bill providing for the retirement of aged persons in the Lighthouse Service was passed unanimously by the Senate in April, 1916, but was not acted upon by the House of Representatives. Recommendation is also made for an increase of salary for lighthouse inspectors, who are considered underpaid in view of the important responsibilities borne by them.

The appropriations for the maintenance of the Lighthouse Service for the fiscal year 1918 are $5,338,680, being $99,650 in excess of those for the preceding fiscal year. In addition there are special appropriations aggregating $1,299,300 for various new works.

Fuel and Our War=Bred Merchant Ships

When we plan things in the United States we do so in a typical American way, which is only another way of saying that we plan them bigger and on a larger scale than is done in other countries. This is particularly true of the programme now well under way by the Shipping Board for the construction and operation of a colossal merchant tonnage to be built and equipped under adverse conditions as regards labor, material and personnel, and complicated further by the urgency of early completion, made necessary by the ravages of the present war.

Progress has been made not only in closing contracts for the construction of these ships, but also in building up organizations which have under way the construction of immense shipyards, in which fabricated ships are to be turned out at a very rapid rate. This has been accomplished in spite of delays at the inception of this project, due almost entirely to the legislation which created the Shipping Board. A large proportion of the preliminary work necessary to these various undertakings has been completed and the balance, we are confident, will be started in the very near future.

The first thought in the construction of these ships has been their early use in carrying on the plans of the Government in the prosecution of the war—they will unquestionably be used for this purpose until the cessation of hostilities. After the war a very large percentage of them will enter the commercial field under the American flag, and in competition with the merchant fleets of other maritime countries. It is to this phase of the work of these vessels, as well as to their war service, that attention should be directed.

The planning and construction of the major portion of the Shipping Boards programme had as predominant motives in design the question of rapid construction, sustained speed, safety against hazards of the sea, minimum material for hull and fittings and simplification of parts. That these requirements, all tending towards an early commissioning, have been well thought out and provided for will not be questioned.

The comparatively recent general knowledge of the fuel situation existing in this country, coupled with the fact that America must play a leading part in supplying fuel to the allied countries, makes it pertinent to consider what effect the commissioning of these ships will have on our fuel problem.

There are approximately 1,400 ships that will go into service under the Shipping Board's programme during the next two years. There will be required not less than 8,000,000 tons of fuel per year to operate these ships. The fuel production in the United States during 1916 was 502,520,000 tons of bituminous coal, 87,580,000 tons of anthracite coal, making a total coal production of 590,-

100,000 tons. The fuel oil production was approximately 300,000,000 barrels. The production during 1917 is estimated at 553,000,000 tons of bituminous coal, 97,000,000 tons of anthracite coal, making a total of 650,000,000 tons of coal. The fuel oil production will not greatly exceed 310,000,000 barrels.

The demands upon our fuel supply for industrial purposes of our own, as well as for the commercial and domestic requirements of the allied countries, will certainly be much greater than during the past year. In 1917 we lacked fully 200,000,000 tons of supplying the demands placed upon us, and during 1918 this excess of demand over supply will at least be doubled. It is, therefore, necessary that anyone who is directly, or indirectly, concerned in the use of fuel give the greatest attention to means for conserving both coal and fuel oil.

Turning to the railroad situation in this country—for the reason that the railroads consume something more than 25 percent of the bituminous coal produced in the United States—it is very apparent that all railroads and all those concerned in the design of steam locomotives and power plants are going to great length to increase the power produced per pound of fuel. A recent bulletin by the Chamber of Commerce of the United States very tersely sums up this question by saying: "The man who wastes coal to-day is an enemy to mankind," and likens the situation to that of people in an open boat at sea with a limited supply of food.

The Railway War Board, composed of executives of the leading railroads of the country, recently issued a bulletin containing specific recommendations which they urged all railroads to adopt as fuel conservation methods. Many of these recommendations had to do with the instruction and education of those handling fuel, and might be considered axiomatic to those who had given any thought to the problem. A number of other recommendations related specifically to improvement in the design of equipment for burning fuel, and earnestly recommended the adoption of devices that had well demonstrated increased fuel economies. Among these were feed-water heaters, improved methods of combustion, high-degree superheaters, specially designed grates and improved draft conditions. It is a fair query as to whether or not equal attention has been given on the part of the Shipping Board to the use of such of these devices as may be adaptable for marine installations.

Without question, the reciprocating engines and turbines of a modern ship are more economical in the use of steam than are the simple, non-condensing engines universally used on locomotives. The boilers in merchant ships are also at least equal in efficiency to those used on locomotives, although the water evaporated per pound of boiler weight or per square foot of heating surface is undoubtedly very much lower, due to the fact that marine power plants are not operating at such a high duty. The question of boilers has also, in the present emergency, been complicated by the impossibility to get sufficient quantities of steel to carry out the original plans and, therefore, a varied boiler construction will have to be used.

There has been little definite information available as to the contemplated use of highly superheated steam, but there should be no reason to doubt the intention to adopt this well-established means of fuel saving. It is also probable that all of the features ensuring improved combustion and better draft conditions that railroads have developed so largely in the past ten years, have been adopted as far as conditions permit. Feed-water heaters, we believe, are being installed as a standard.

It is the extremely critical situation as regards the world fuel supply that justifies continued efforts to arouse the thoughts of everyone to do his part in preventing, so far as may be possible, a shortage in these commodities which not only are the life-blood of our own industrial world and of our domestic happiness, but in the present world struggle have such a tremendous effect on the successful prosecution of our part in the conflict.

Deficiency of Coal in 1918 May Amount to 130,000,000 Tons

IN discussing the general need of fuel conservation in the boiler rooms, Van. H. Manning, director of the Bureau of Mines, Department of the Interior, recently issued the following statement:

There is one phase of the present coal situation which may put an entirely different light on the supposed increased production of coal of the present year. In round numbers there was produced 600,000,000 tons of fuel last year. Statement has been made that 50,000,000 more tons will be mined this year. The preparation of this increased quantity of coal has not been as good as in times past. Analyses of samples show in many cases a greatly increased quantity of ash. Repeated cases are brought to the attention of the Bureau of Mines where coal which would run from 6 to 8 percent ash in normal times is running from 12 to 18 percent of ash in these abnormal times. Complaint about the preparation of coal is very general, and it is not at all improbable that 5 percent more ash is included in this year's coal than in previous years. If such a figure is true, it means that 32,500,000 tons of the estimated output of 650,000,000 tons is nothing but increased ash. If we can imagine over 600,000 carloads of ash being added to the present burden of transportation, the evident effect on car supply and transportation troubles would be seen.

If this were the end of the matter it would not be so bad, but there is another factor well known to engineers which is apt to be overlooked by the non-technical user. The extensive experiments carried on by the Government at the St. Louis Exposition showed that with the coals used there was a decrease of about 1½ percent in efficiency for each 1 percent addition to the ash content of the coal—that is to say, the inclusion of more ash with the coal decreases the value of the fuel not only the amount equal to the useless ash, but it makes the remaining good coal less effective to the extent of 1½ percent for each 1 percent of ash. The inclusion of 5 percent more ash in the fuel, therefore, means a reduction in efficiency of the remaining good coal of about 7½ percent, which, added to the 5 percent useless ash, makes a total reduction in effectiveness of 12½ percent.

According to this point of view, although 650,000,000 tons may be produced in 1917, its effectiveness, as compared with previous years, is probably about seven-eighths of this, and equivalent to a production of normally prepared coal of about 570,000,000 tons. We have, then, instead of an increased production as compared with last year, an actual decrease of effective coal of about 30,000,000 tons. If this is added to the estimated increased needs, due to our accelerated activities, of 100,000,000 tons, we have a deficiency of the equivalent of 130,000,000 tons, instead of 50,000,000 tons to make up by good engineering and true fuel conservation in the boiler room.

LETTERS TO THE EDITOR

Co-Operative Management

On page 428 of the October issue, Mr. Arthur F. Johnson writes most interestingly on a subject of major importance to all its readers. Knowing that the pages of this journal are read very carefully by shipbuilders, I make bold to set down my views here on the subject of cooperative management, or, more broadly speaking, the relations between employer and employee.

From a long and varied experience in this and other countries, I am forced to take views diametrically opposed to those of Mr. Johnson. His views are broadly that the employer should assume the rôle of parentalism with those whom he employs. I assert that this is not wise or to the liking of the employed. The employer should provide comfortable and sanitary surroundings for his help and the employee should carry out his work according to the direction of his employer and receive therefore the agreed wages for salary. After that honors are easy. The workman does not live who is not more content to go and buy his pleasures, recreation or education as he wants them than to be guided in any of these advantages by the men for whom he works. It is natural to believe, and is true, that the firm or employer who is able to erect social halls and out of the earnings of his employes provide educational advantages must be able to pay higher wages if he leaves these supposed philanthropic actions uncarried out. Any group of employers would not be pleased—in fact, would resent—interference by employees in their own social or educational actions, and what is sauce for the goose is sauce for the gander.

There are conditions where a works situated in the country might wisely provide these supposedly advantageous adjuncts, but in almost all the cities and towns of the United States can be found night schools run by the authorities where mechanical drawing and other studies can be undertaken by an employee of any works within the limits of the city or town. These night schools, I know from a long experience of running them, are attended by the most meager percent of workmen. The libraries are used very largely as places of rest by workmen, but the great majority of books to be found there are taken out by women and are not usually of an educational character.

I differ entirely from Mr. Johnson in his opening sentence. It is not lack of understanding between employer and employee which makes manufacturing difficulties as regards labor, but the desire of the workman to get higher wages and the disinclination on the part of the employer to pay them. I have met and conversed with men who agree with Mr. Johnson, but in all cases these men have been in the employ of some large company carrying out the ideas Mr. Johnson suggests, but as in so doing they make their living it is only natural that they should hold such views. I have never met an employee who did not positively and emphatically assert that he would be far more content to be paid higher wages, and with them pay for his education and amusement. What men will work hardest for is a financial gain. It was put to me once in this way: I gave an old blacksmith an order to make a lot of safety valve levers. He turned out about thirty a day. I then offered him a piecework price and he turned out over ninety. I brought this difference to his attention and asked him if he thought it just fair. "Well," he said: "Mr. Forbes, it's just this vay. When I pounds for you I pound so hard, but when I pounds for myself I pounds just as hard as I can." This old fellow was a Swede and I think he put the case in a nutshell.

It seems ideal to have workmen interested, financially, in the firm for which they work, and, in a certain way, it is; but a stockholder—even a minority one—can in many States demand access to the books of the company, and in so doing obtain information which, if given out, would be extremely useful to friendly rivals, and therefore to a disadvantage to the company. Where workmen have owned stock I have generally found them apathetic as to how the company was run, apparently having the feeling that the company would pay no attention to anything they might say, and far too often they seem to hold the idea that in owning stock in the company it is a preventive to their discharge and that liberties can be taken by them on that account.

Dividing profits among workmen presents few difficulties, but any attempt to make workmen divide losses is extremely difficult. Yet it is as fair on one side as on the other. The workman's argument against paying any losses is that, having no voice in the management of the company, it is unfair to charge the losses to them; yet if workmen will exert themselves to turn out work rapidly and well, they can prevent losses. Nothing would make workmen exert their best efforts more than a clear understanding that if they failed to get out the work quickly and well the loss would fall upon them. I know of one system which worked admirably in regard to dividing profits with the men, but in this case no losses were made and the business was very prosperous.

The system was this: A ship was bought for trading between ports in the Mediterranean. The sailors and officers of the ship were paid their regular wages and the investors eight percent on their money. The surplus over and above this had a certain amount taken from it for emergencies and the balance was divided not only with the officers and crew, but with the investors. The basis on which this was done was that every dollar of investment and the yearly pay of the officers and crew were added together and the undivided surplus was divided by this amount. This gave what was called a working interest for every dollar invested and each dollar paid as wages. In this way an officer getting $600 a year would get an additional amount obtained by multiplying the amount of his salary by the working unit.

This was satisfactory both to investors and employed—in fact, it worked so well that the system was employed by a large line of steamers. It had the great advantage in my mind of placing in the hands of the wage earners their own earned money, with which they could buy stock or any security they might desire, and there was no coercing, so to speak, to make the men buy stock of the line. It may be said, of course, and quite truly, that the sailors would waste the money and buy no securities at all, but in foreign countries workmen seemed to grasp the idea more clearly than they do in America that it is wise to save.

Mr. Johnson says that it is to the advantage of a firm to take an interest in the doings of its employees outside of business hours. It is, in my opinion, none of the firm's business. Reverse the conditions and how does it look?

Again, Mr. Johnson says that by certain actions the workmen are encouraged to make known their grievances. I think most proprietors will agree with me that no encouragement is needed on this point.

On the rule question I again entirely disagree with Mr. Johnson. The best run shop that I ever saw had no rules or regulations whatever. The men know at what hour to

come to work and when to quit, and if their action at any time was detrimental to the interest of the company the foreman spoke to them about it. This was far more effective than posted rules.

A coddling system has never prevented strikes or made a better feeling between employer and employees. There is no panacea save one, and that is gradual improvement of human nature. Finally, the only real encouragement to men at the present time is good pay now and a prospect of getting more pay by and by.

New London, Conn. W .D. Forbes.

"The Return to the Reciprocating Engine"

The criticisms brought out by Mr. F. S. B. Heward in the December issue, regarding the editorial on the above subject published in the November number are very interesting, but I do not think Mr. Heward's criticisms are in all cases justified or borne out by the actual facts of the case. I am, of course, writing from a purely turbine engineer's standpoint and writing in defense of the turbine, particularly for auxiliary drive.

Before going into detail regarding these small machines there is one statement that Mr. Heward questions in connection with the main turbine drive, which I think an investigation would show was correct as given in the original editorial, namely, that the gear capacity of the country *is* taxed to the limit. I have been informed by various shipbuilders that in view of the fact that they cannot obtain gears, they have been obliged to redesign the turbines so they can be direct connected to the propellers for the sole reason that they were unable to obtain gears.

The same story has been told by the contractors for merchant ships, and on account of the comparatively uneconomical operation of a direct connected turbine the reciprocating engine has been adopted for this one and only reason.

Referring to Mr. Heward's comments on reliability, I think the author of the original article referred particularly (when talking about reliability) to the auxiliaries. Mr. Heward says: "Exception is taken to the statement that 'the turbine is obviously better adapted for this duty . . . than the reciprocating engine,' and it is an open question whether the foreign navies have appreciated this fact and have switched over from reciprocating engines to turbines wherever possible for this one reason. . . . To couple this remark with the above statement is a very broad and positive assertion which, in the opinion of the undersigned, lacks foundation. I would like to refer the writer to Capt. Dyson's article on page 545 of the same issue. Referring to steam-driven blower sets Capt. Dyson states: "One of the great sources of failure to hold high speed for any long-continued period of time with all classes of vessels had been the continually recurring breakdowns of forced draft blowers with engines of the reciprocating type. These had been done away with, and blowers driven by electric motors substituted for battleships, beginning with the *Michigan* and *South Carolina*, as already stated. . . . Fans by later performance (referring to turbine driven fans) instilled such confidence that no other type of blower than that of the turbine driven has since been considered for destroyer work, and in later vessels of other types it has even shouldered the electric driven fan out of the way, as its flexibility of control is so much greater."

Now this statement is not from a turbine engineer, but from one whose knowledge is based on the actual performance and one whose authority to talk on this subject is beyond question.

It would take too long to go into detail regarding the gradual elimination of the reciprocating engine by the steam turbine on board the United States government ships. But it is sufficient to say that the turbine driven auxiliaries are given preference in the Navy wherever they can be practically used.

Referring to the statement made by Mr. Heward that the foreign countries have not switched over to turbine drive as indicated in the original editorial, let me cite the following facts. The marked success of turbine driven fans for destroyers resulted in the designs for these identical machines being purchased by Yarrow & Company, of Scotstoun, Glasgow, who have since that time used this drive as standard. Other builders have been developing fans along similar lines and for forced draft work both in torpedo boat destroyers and steam-driven submarines, turbine fans are, I believe, the only type adopted.

This same design has also been adopted to a large extent by the Italian Navy, and in this instance a great number of the turbine fans were manufactured in this country. The type of fan used to a great extent by the German Navy is shown in the Transactions of the Society of Naval Architects, Vol. XXIII, plate No. 76.

For generator drive the steam turbine is absolutely standard now with all modern navies.

Referring to the merchant marine, while the introduction of the turbine up to the present time has not been so universal as in the navies, we see a bigger demand for this type of auxiliary every day.

Referring to the statement of Mr. Heward: "Undoubtedly the turbine draft gear would not require as much space and would be somewhat lighter, but does its present design meet with the requirements of steady and continuous running and does the usual type of fan supplied at these high speeds actually meet forced draft requirements?" I think that this could not be better answered than by the quotation of Capt. Dyson's referred to above.

Referring to the question of personnel, I heartily agree with Mr. Heward that the authorities at Washington are not going calmly to turn over the operation of the new boats to men without experience, but one cannot help but form some opinions on this subject when in practically every paper we see this question is brought up as to how we are going to man these boats efficiently. It is true that the men will be trained and trained as well as circumstances permit, but if shipbuilders can help the situation any by fitting their boats with apparatus that is acknowledged by such an authority as the Navy Department to be more reliable and require less attention, then it would seem that the best thing to do would be to help the situation by adopting this apparatus.

W. J. A. London.

The Steam Motors Company, Springfield, Mass.

Loss of Merchant Tonnage.—According to figures supplied by the Patriotic Education Society, Inc., Washington, D. C., the loss of world's tonnage up to September, 1917, actually amounted to 12,000,000 tons, although the destruction by submarine and mine was only 8,783,080 tons. This is figured by estimating the unusual depreciation due to the exigencies of war and including the ships that are held in port, as well as the falling off in the world's tonnage. If the war had not intervened, it is estimated that the world tonnage in 1917 would have been about 59,000,000 gross tons.

Manning the New Merchant Marine

All American Merchant Ships, Except Troop and Supply Ships, To Be Manned by Merchant Officers and Seamen

IT has been announced by the United States Shipping Board that, through co-operation with the Navy Department, the Board has worked out a plan for manning the new merchant marine by which it is expected that all interests involved in the great task of transporting and supplying our armies overseas will be adequately protected.

By this plan the bulk of vessels under the American flag, whether engaged in the transatlantic trade or elsewhere, so long as they retain their character as merchantmen, will continue to be manned, as hitherto, by merchant sailors. This is in accordance with the practice followed by the British, which is held to have worked out satisfactorily under war conditions.

Troop ships and vessels carrying whole cargoes of munitions or supplies for the army and navy, however, for military reasons will be manned by naval crews.

Naval Crews for Transports Only

This plan is expected to provide a practical solution of a problem that has troubled both the Navy Department and the Shipping Board for several weeks past. It appears to meet the practical demand of the Navy for naval control of vessels doing naval duty, while, in preserving the civilian character of crews on all other vessels, it follows the best traditions of the American merchant marine.

Tentative proposals, that in the interests of discipline all vessels crossing the North Atlantic into the war zone be manned by naval reservists, were the subject of several recent helpful conferences between naval officers and representatives of the Shipping Board.

Acting on the plan evolved, which is the result of mature deliberations, the Shipping Board has adopted a comprehensive programme for securing and training civilian crews that will be needed on the new fleets of the merchant marine.

Fifty Thousand Men to be Enrolled

The Shipping Board will proceed, through its Recruiting Service, of which Henry Howard, of Boston, is the chief, to enroll men in all the States for the merchant service, to a possible maximum of 50,000. Headquarters for enrollment will be at the Boston Custom House, while the home station of the training squadron will be at the Federal Dock, East Boston.

Training Ships

Two steamers have been taken over by the Shipping Board for use as training ships. They are the *Calvin Austin,* a Boston passenger vessel, which in the past week made a mercy voyage to Halifax, and the *Minnesota,* a large passenger steamer from the Great Lakes. As the *Minnesota* met with an accident in New York waters recently, the *Austin* probably will be the first commissioned as a training ship. It is possible that as the work advances other ships, based on other ports, may be put into service.

Each of the two ships named will accommodate a "class" of 600 men, who will be subject to systematic and intensive schooling, each in his particular line of work, under a plan that has been worked out in detail by the Shipping Board's Recruiting Service, and has just received the official approval of the Board.

For the seamen the most important training will be in lookout work, lifeboat drill and fire drill. They also will be taught knotting and splicing of hawsers and wire ropes, and the routine of work about ship at sea. This instruction will be imparted by able seamen employed as instructors, each having under him a squad of ten men. By this method it is expected that the instructor will be able to impart to his pupils in a month as much knowledge of seamanship as the average green man would get in several months of ordinary seagoing. This instruction will be given largely at sea, as the men will be taken out for frequent trips offshore to harden them to sea life and to "get their sea legs on."

Instructions for Engine Room Crews

The engine room men—firemen, oilers and water tenders—will be trained on the same system, with an instructor to a small group of men.

Cooks and stewards will have actual work of preparing meals for the crew, under the direction of seasoned sea cooks.

Men who have had seagoing experience will be given precedence in the selection of the new crews, and the best trained among them will be encouraged to enter the Board's training schools for merchant officers, thirty-eight of which have been in operation since last June in different parts of the country.

Men without sea experience will also be enrolled. Any citizen between 21 and 31, in good health, is eligible for this service. Men accepted will be given $30 a month training pay, transportation to the point of training, an outfit of clothing, and board.

Wage Scale

The men trained will be added, on a fixed percentage basis, to crews formed on a nucleus of veteran seamen. When shipped for sea duty they will be paid on the standard wage scale of the merchant marine, the highest in any seagoing service in the world. Crews crossing the Atlantic now receive a war bonus of 50 percent on their wages, making the earnings of seamen or firemen $90 a month; of a quartermaster or boatswain, $105 a month; of an oiler or water tender, $97.50 a month, and of cooks, as high as $112.50 a month, with food and lodging furnished.

Co-operation of Merchant Officers and Seamen

In formulating its plan for manning the new ships, the Shipping Board has had the co-operation of organizations of seamen and officers now in the merchant service. As early as last May the Board approved a plan proposed by the Seaman's Union for adding sailors to existing crews for training. This has been followed successfully and will be continued in conjunction with the present plan.

Structural Steel for Ships.—The Carnegie Steel Company, Pittsburgh, Pa., has issued a sixteen-page pamphlet giving the standard practice recommended by American steel makers as adopted by the Emergency Fleet Corporation for structural steel for ships.

The Shipbuilding Situation*

Constructive Criticism of Relations Between the Government and Shipbuilders—Recommendations

BY JOSEPH W. POWELL †

TO-DAY our first thought in talking of ships should be the Navy and its programme. If any one had predicted seven months ago, when war was declared, that to-day would find the Navy's programme in the condition that it occupies, his forecast would have been viewed with utter incredulity. It is not permitted to say just how extensive this programme is, but the business spirit that has actuated the Navy Department in its handling of the situations produced by our entry into the war has met the utmost that could have been expected. One instance which may be cited as indicative of the expedition and effectiveness with which the Department business has been transacted is the fact that the biggest single contract that has ever been settled as a single order anywhere in the world required just two meetings of a total of four hours' sittings to negotiate. This contract will stand as a model for any other Government business.

Dealings With Navy Department Satisfactory

The desire to achieve results, to deal fairly with the contractor while safeguarding the interests of the Navy, has made this business something that is only contemplated by those who are taking part in it with the greatest of pleasure, and there is no man who is dealing with the Navy Department who will not concur in my statement that more prompt and courteous treatment, more satisfactory and expeditious business, can be done with that Department to-day than with any other branch of the Government. In passing, it is of interest that this has been accomplished without change in the Department's organization, and that barring its really serious shortage in personnel there seems little limit to the volume of work that it is prepared to handle with the facility and dispatch so necessary to the result that must be obtained to meet the situation.

Interests Not at Odds

In our association with the Navy Department during the last few strenuous months there has been borne in upon both contractor and Department the fact that their interests were not at odds, but were really the same, and that there has grown up a mutual understanding and appreciation, a mutual respect and confidence that can only result in the greatest good for the country at this time. Moreover, the Department has done that wisest of things, when results are desired; they have so far met with the proper requirements of the situation as to leave the responsibility for results in the hands of the shipbuilders, so that, barring the labor situation, if we fail to perform, there are no valid alibis that we can claim. I am proud to say that in its progress toward material preparedness the Navy Department leaves little to be desired; and as the months go by and the results begin to be achieved, our Navy will be able to occupy the commanding position that is so essential to the safety of this nation.

For many years the shipbuilding business in this country was big enough to be a target for politicians and labor leaders, but not big enough to be a power. To-day it has come into its own, and with the growth of public sentiment in favor of a merchant marine, it should in future be able to speak with no uncertain voice. At a recent conference in Washington, five shipbuilders sitting around the same table represented a business employing no fewer than 50,000 employees, and where a year ago there were hardly more than 70,000 men engaged in shipbuilding in the United States, the demands for the year 1918 will require upward of half a million men in this country.

Shipbuilding Industry Should be Represented in Council of National Defense

Nothing is more vital to-day to the success of the allied cause than the rapid production of merchant ships in the shipyards of this country. Is it not strange, therefore, in the light of this situation, that there is no member of our business on any of the advisory boards in Washington who can speak with the voice of authority in high places? There are to-day available a number of men of vision, experience and business ability who might represent this industry on the Council of National Defense, gentlemen who will measure fully up to the high standard of the other members of that Council, and I hope that in the Society of Naval Architects and Marine Engineers a motion will be made and unanimously carried to petition the President of the United States for the good of the nation to appoint such a representative.

Two Million Gross Tons Probable Output of Merchant Vessels in 1918

In speaking of the Shipping Board, the enormousness of the Emergency Fleet Corporation is little conceived by the general public, nor is it generally realized how difficult a task has been assigned to various gentlemen who have been in control of this company to build up a working organization that is capable from a technical and a business standpoint of handling the affairs entrusted to them. There are one or two matters, however, bearing upon the Corporation's business which should be discussed.

In the first place, a measure of performance is being set for our industry which is quite impossible of achievement during the coming year. In 1916 there were about 550,000 gross tons of shipping turned out in the shipyards of the United States. Last January I predicted that this year would see about 1,250,000 tons of shipping, but various labor and material conditions have arisen to reduce its output so that, while it is difficult to speak in view of the lack of official reports, I do not believe that the gross tonnage that will be completed this year will very much pass the three-quarters of a million mark. Next year the old line yards will, to a large extent, be serving the Navy, so that the total merchant ship production from them will be actually less than in 1917, so that the bulk of the increase in merchant vessels must come from new yards, the most important of which are still far from ready to lay their first keel. It is my sober judgment that a production next year of 2,000,000 gross tons will be a record of which our industry can be proud, and that this mark will not be achieved unless labor and material conditions are far better in control than has been the case during the present twelve months.

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* Extracts from address delivered at annual banquet of Society of Naval Architects and Marine Engineers, New York, November, 1917.

† Vice-president Bethlehem Shipbuilding Corporation, South Bethlehem, Pa.

Please note that ships built have always been reported as gross tons, and not "deadweight" tons. Great Britain's maximum output of 3,000,000 tons was measured in gross tonnage. The submarine sinkings have been reported in gross tonnage, and in order to keep this issue clear, the tonnage turned out in this country should be reported on this basis, and not on the basis of deadweight carrying tons, the only effect of which is an apparent and not a real increase. For instance, the 2,000,000 gross tons which I have mentioned can be called 3,000,000 deadweight tons, but the cubic capacity of the ships, which is the recognized measurement capacity for cargo, is the same in either case.

Difficulties With Emergency Fleet Corporation

There is a second matter upon which I wish to touch. There has recently been appointed a board of five members representing the Atlantic Coast Shipbuilding Association, whose duty it is to confer with the Emergency Fleet Corporation on matters affecting our industry. If this board acts wisely and if its counsels are received in the spirit in which they are given, it is my belief that a very decided step will have been taken towards smoothing out the numberous difficulties and misunderstandings between the Fleet Corporation and the shipyards. Shipbuilders are not thinking primarily of profit to-day, but no sane man can continue to run a business who does not pay sufficient attention to this important factor to be sure that his returns will permit his business to live. No sane man can blindly enter into contractual obligations to perform the impossible or to control the uncontrollable. I believe the most important question before the Fleet Corporation and the shipbuilders is the establishment of mutual confidence and esteem, and these through the Committee are now in line for a solution that will permit the shipbuilders to spend more time at home building ships and less time in Washington at fruitless conferences. And this leads up to the last and most important of the questions which must be considered.

Shipbuilding a Question of Labor

The performance of shipbuilding during the next twelve months is going to be the performance of labor. If this is labor's war and labor is in it to do its share, the next twelve months will see astonishing results. I personally believe in the individual American workman; when I talk to him alone, or in small groups, I find him reasonable and fully competent to understand the necessities of the situation. It is my belief, based to a small extent on personal observation and to a larger extent on the evidence of people who have been closely associated with them in Washington, that most of the national labor leaders are sincere in their desire that labor shall do its proper part in the war. But labor itself is really difficult to control. Let me cite two instances:

Labor Troubles

Some three weeks ago, because of a question of rerating in the Fore River machine shop had not been handled to the liking of the men, without ever conferring with the officers of the company some 1,200 men laid down their tools and walked out of the yard, thereby stopping absolutely the most vitally important work under way for the Navy. I was informed from Washington in less than twenty-four hours that telegrams had been sent from the labor leaders there directing the members of the International Association of Machinists to return to work pending a settlement, but the actual representatives of the union on the ground by their individual efforts were able to defeat a motion that was made to this end and to hold the men out for several days more, until they finally agreed to an arbitration which the company would have been entirely willing to offer its men without their ever leaving the yard for one moment.

You have all read in the last few days of the orders that have gone forth from Buffalo to the Boston unions to return to work on certain war jobs at the Watertown Arsenal and Navy Yard. You may also have noticed that this order was disobeyed, and this for the reason that while the various trades in Boston are each members of the American Federation of Labor there is a local federation made up of the various Boston trade union bodies, known as the Building Trades Council of Boston, which is not a member of the American Federation of Labor, and which gives little or no allegiance to it. It also exercises a closer control on the various trade unions than the national society, and has so far been able to defy the orders from the national union officers. The net result of this is that there are no responsible heads with whom dealings can be carried on and who can deliver the goods. The only point at issue in these strikes, which are sympathetic, is the forcing of a building contractor who has always operated open shop in Boston to change to closed shop.

Campaign of Education

Now the proposition becomes one of the most practical importance and one that only can be immediately solved, in my judgment, by a campaign of education. If Vance McCormick were called to take charge of such a campaign as this country has never seen in any political era, if he were called to enlist under him without respect to politics or creed those men who have demonstrated their abilities to carry home to the crowd the thoughts that are uppermost in the minds of men to-day, if Oscar Underwood, Theodore Roosevelt, Champ Clark and William Howard Taft and hundreds of men of ability and forcefulness could be enlisted to go into every shipyard and munition plant to talk to the men and to bring home to them the fact that this is their war, I believe it is possible to eliminate the troubles with which we are now confronted. This is no time for industrial disputes. No plant engaged in building ships can refuse a demand from the Government to accept arbitration on questions of wages raised by its employees, and no more can any body of employees refuse to meet the situation in the same spirit. If this cannot be accomplished, these vessels upon which we are working to-day will still be built, but they will be built by the American workmen for the German Kaiser, and not for our great country, these United States of America.

Another Influential Force

There is another force that will aid in this campaign as time goes on—the influence of mothers and fathers and brothers of the men who are offering their lives in this country's defense. A man in the Fore River blacksmith shop only a few days ago said to me: "Mr. Powell, I have four boys in France. Do you think I am going to strike?" And as our dead and crippled soldiers call out to us that the rights of the men at the front to materials with which to make their fight must be met, the force of mighty public opinion will more and more make itself felt.

A few nights ago, at a meeting of the Economic Club in Boston, when a long discussion had taken place on the rights and attitude of labor and capital towards this war, when much had been said of the sacrifices that both were making, Dr. Eliott closed the evening's proceedings with a brief and eloquent address. He said, in substance, that for either capital or labor to talk of sacrifice at this time was futile; that there was only one sacrifice—that made

by the man who offered his life and his health for the salvation of the nation.

Now we must make the workmen feel these facts, and to start the campaign of education the Bethlehem Shipbuilding Corporation will head a list to defray its expenses with a generous subscription, and I will personally subscribe to the extent permitted by my means.

And if labor can be brought to that frame of mind where it will work six days a week instead of a little more than four days and a half, will give one hundred percent production instead of seventy-five, will go wholeheartedly into this mighty game, then I have no fear but that in the fullness of time victory will rest with these United States and the world will be a better and a happier place for those who come after us, and I further say that we cannot successfully fight labor and Germany; and if we must do both, then are we doomed to terrible defeat.

To sum up briefly the foregoing, the Navy is splendidly taking care of its needs. The opportunity should be seized to urge upon the President the selection and appointment upon the Council of National Defense of a representative shipbuilder, the committee of shipbuilders organized to work with the Emergency Fleet Corporation should be met in the fullest spirit of co-operation, and, last, and far the most important, a national campaign of personal education should be immediately undertaken to get labor in line for the ending of the war.

First Keel Laid at Newark Bay Yard

John Hunter, Representative of Shipping Board, Drives First Rivet in Keel of First Fabricated Steel Ship Laid Down at Newark Bay Plant

ON December 20, John Hunter, representing the Shipping Board, drove the first rivet in the keel of the first 5,000-ton fabricated steel ship to be laid down at the new Government shipyard erected on Newark Bay by the Submarine Boat Corporation, of New York, acting as agent for the United States Shipping Board Emergency Fleet Corporation. This marks the beginning of a tremendous drive for the rapid production of ship tonnage, upon which depends the effectiveness of the United States in the war.

The yard is located at Port Newark Terminal, fifteen minutes distant from the heart of the city of Newark, on Newark Bay, and comprises 125 acres of land which is ideally situated for a shipyard. The land has a frontage of one-half mile on Newark Bay, where the shipyard is built. Twenty-eight shipways are now under construction. A number are already completed. On the south end of the property, docks are built where the ships, when launched, will be moored while they are being fitted out with the propelling apparatus, including turbines, boilers, deck machinery, etc.

Characteristic of American energy and ingenuity, this enormously large yard was over 90 percent completed in seventy-six days and marks the completion of one of the largest shipbuilding plants in the world.

Equipment of the Yard

This yard is, in reality, an assembly point which will be fed by over forty-six steel fabricating ships accustomed to manufacturing steel material for skyscrapers, bridges, gas plants, etc. The number of workmen required on the hull construction alone, when the plant is going at full capacity, will be over 15,000, while the number of workmen in different locations from the Atlantic Coast to as far west as Milwaukee in fabricating of the raw material will represent over 30,000. The Newark Bay Shipyard will be the main assembly point for hull material, as well as turbines, deck machinery, etc., that goes to complete the entire ship. Over 15 miles of industrial standard gage railroad tracks will be laid on the property and over 30,000 piles will be driven to complete the shipways. The main buildings are of steel, two 700 feet long; the administration building of 40,000 square feet already occupied by over 400 employees. The other steel buildings, comprising machine shops, storage warehouses, equipment shops, etc., are rapidly nearing completion.

The workmen for erecting the ships will come from all parts of the country and will comprise trades which heretofore have been utilized in office building and bridge construction. Schools will be established at the plant for training these men in ship work, and it is expected that men accustomed to structural steel erection can very soon become, by the methods employed at the Newark Bay Shipyard, skilled in steel shipbuilding.

Housing of the Workmen

The housing conditions at Newark have been a problem that the shipyard has had to contend with, but through the Board of Trade of the City of Newark, and the Emergency Fleet Corporation of Washington, additional housing facilities will be afforded in the near future to take care of the great number of new men who will be called upon to work at this plant. While the demand for new houses is of the greatest importance in connection with the Newark Bay Shipyard, temporarily the cities of Newark, Jersey City and New York can take care of the large number of men who will be employed, as within a circle of ten miles of the plant over 7,000,000 people reside, making this location one of the most ideal for this enterprise.

The 5,000-ton ship which the Submarine Boat Corporation will build at this yard has been designed and worked out so that structural steel can be utilized in its construction yet equalling in every way the highest standard of shipbuilding, and the ships when completed will carry the highest classification from both English Lloyd's and the American Bureau of Shipping.

The Shipbuilding Programme

The programme is for this yard to complete 150 of these ships in the shortest possible time. Three keels were laid in December, additional ones in January and each one thereafter, it being possible to lay twenty-eight keels and have twenty-eight ships under construction at one time in this yard. With these unparalleled building facilities the progress to completion will be hastened.

It is estimated that over one thousand cities and towns of the country will be directly or indirectly interested in supplying material, labor and equipment for the vessels that will be constructed at the Newark Bay shipyard, and the assistance that can be rendered by the individuals working on this big task will be felt from one end of the country to the other.

Shallow Draft Motorships for Use on the Volga River Designed by American Naval Architect for Russian Owners

Oil Tankers of 3,500 Tons Deadweight Carrying Capacity and Cargo Boats of 1,500 Tons Capacity Limited to 7 Feet and 5 Feet Draft Respectively

THE firm of Nobel Brothers Company, Petrograd, Russia, are building, from plans furnished by J. Murray Watts, naval architect, of Philadelphia, a fleet of oil tankers for use on the river Volga. As the Nobel Brothers Company has its own shipyards and its own factories are constructing the Nobel-Diesel engines, it is unusually well equipped for the construction of steel vessels of this type.

The great difficulty of navigation on the river Volga is the fact that during periods of low water the deepest draft vessels that can be utilized in certain reaches of the river is limited to 7 feet. The interesting problem, therefore, arose of designing self-propelled steel vessels of large capacity, with this light draft, that would have a speed when loaded of 12 miles per hour.

Oil Tankers

The general dimensions are: length, 432 feet; beam, 64 feet; depth, 14 feet, and load draft, 7 feet. The vessels are constructed of mild steel. The oil cargo is carried in bulk in the deep double bottom and expansion trunk. There are four main propelling engines of the Nobel-Diesel type, each of 750 horsepower, and each driving a three-bladed bronze propeller 80 inches in diameter and 80-inch pitch, at a rate of 225 revolutions per minute, giving a speed of 12 miles loaded and about 14 miles light. There are three rudders hung outboard, actuated by a Dake steering engine aft, and controlled from the pilot house forward.

Besides the 3,500 tons of cargo in the shape of petroleum in bulk, there are tanks for the main engines and auxiliary engines.

In addition to the oil hatches leading into the expansion trunk amidships, there are two rows of hatches on either side, opening into the space above the oil-carrying double bottom. This space is used for miscellaneous cargo. The vessels will run from the oil fields up the Volga River to various discharging stations and oil refineries, making a run of about 1,500 miles. On the return trip the cargo oil tanks will be empty and the hold space above these tanks will be utilized for miscellaneous freight.

These vessels are equipped with six king posts, three on each side, and cargo booms handled by oil engine driven winches. Excellent accommodations are provided for the crew, the engineers being berthed in the deckhouse aft; the navigating officers in the deck house forward, and the crew in the forecastle.

Shallow-Draft Freighters

The Nobel Brothers Company also awarded to the same designer the contract for the drawings and specifications for a fleet of cargo boats of even less draft than the oil tankers, which can navigate the shallow tributaries of the Volga. These vessels carry oil in barrels in a large

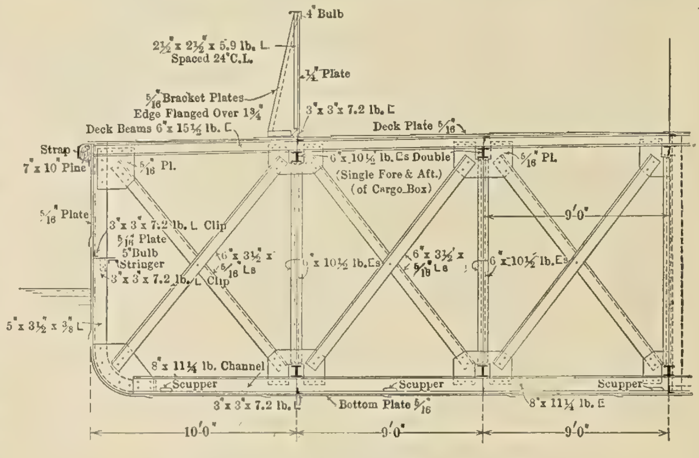

Fig. 2.—Midship Section of Freighter

cargo box on the main deck. The oil is brought from the oil fields to the main distributing centers on the trip up river, and lumber and other bulk cargoes are loaded into the cargo box for the return trip.

The boats of this class are 325 feet long, and on account of the shoalness of the upper Volga River are re-

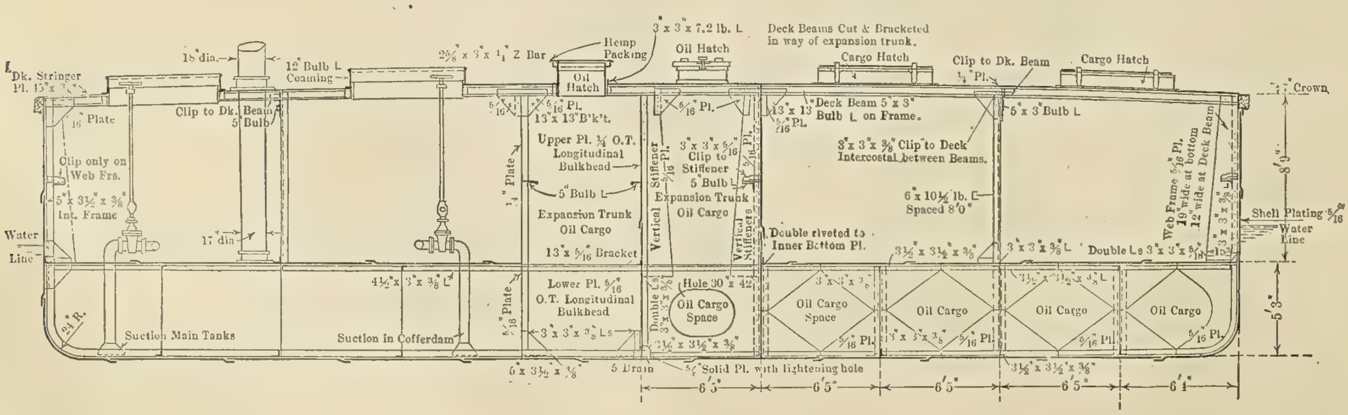

Fig. 1.—Midship Section of Oil Tanker, Showing Main Scantlings

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SHALLOW DRAFT MOTORSHIPS FOR NOBEL BROS., PETROGRAD, RUSSIA

Designed by J. Murray Watts, Naval Architect, Philadelphia, Pa.

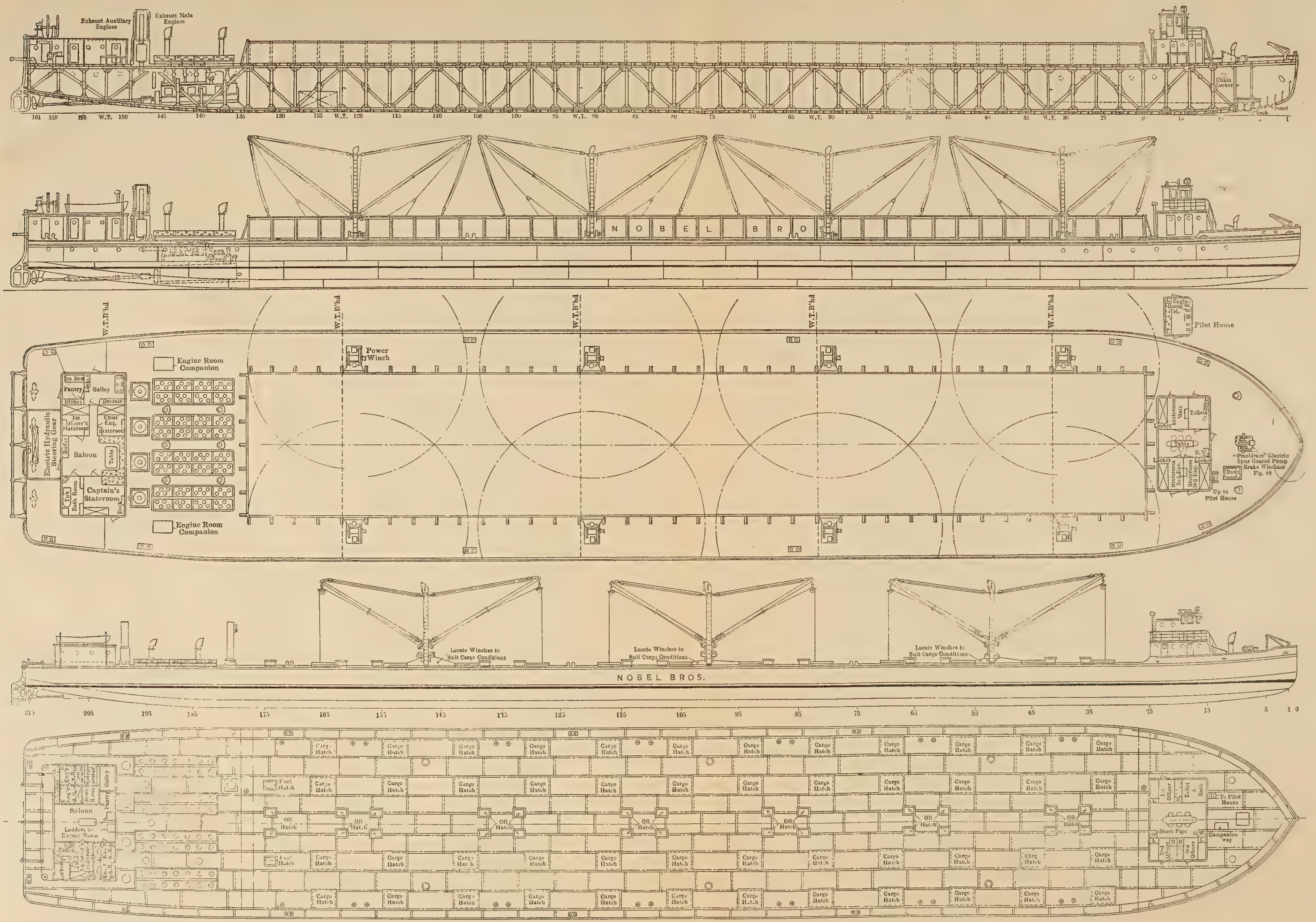


Fig. 3.—General Plans of 1,500-Ton Cargo Vessels (upper cuts), and 3,500-Ton Oil Tankers (lower cuts)

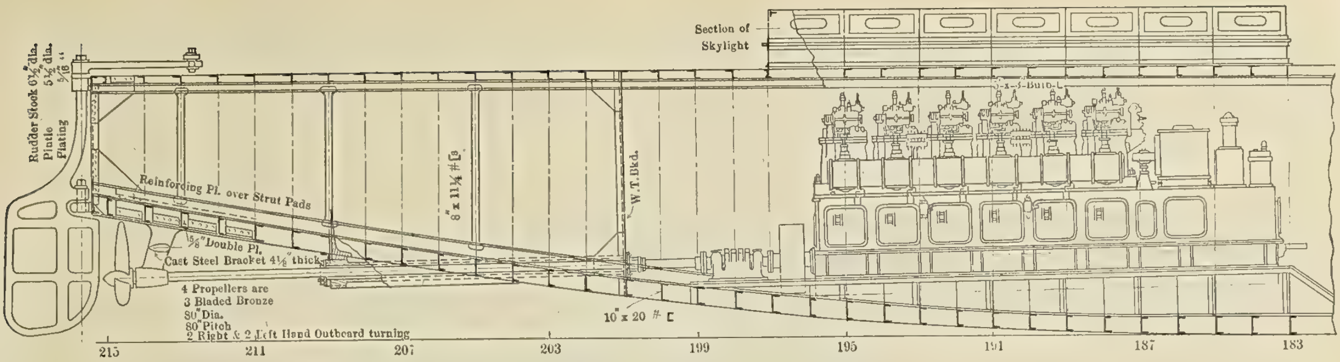


Fig. 4.—Machinery Space of Oil Tanker

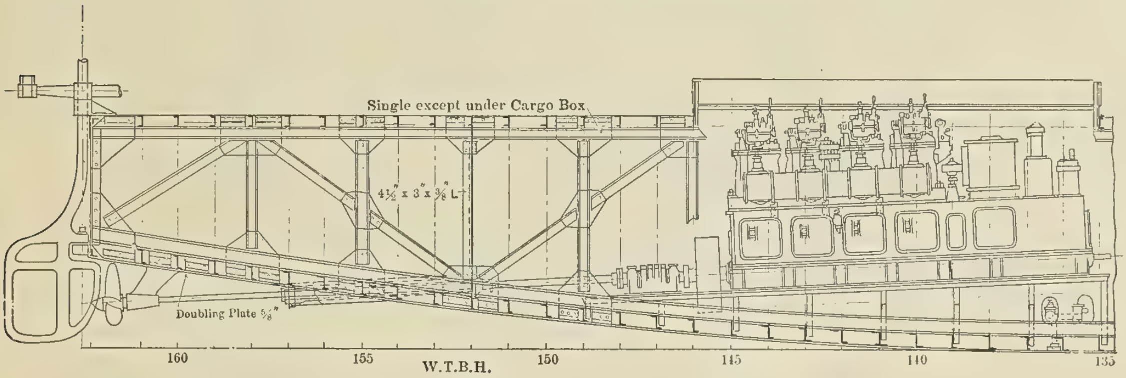


Fig. 5.—Machinery Space of Cargo Boat

stricted to 5 feet draft loaded. These vessels carry 1,500 tons of oil in barrels, besides 20 tons of fuel oil. They are quadruple screw boats driven by four 450-horsepower Diesel engines driving propellers 58 inches diameter and 58 inches pitch, giving a speed loaded of 12 miles. To handle the cargo a complete outfit of cargo winches and derricks is fitted, there being eight king posts, four on each side, and sixteen derricks. Owing to the shoalness of the boats, a very complete system of trusses is run throughout the hull, giving the necessary transverse strength against hogging and sagging strains.

Very liberal accommodations are given for the crew in the two deck houses and in the forecastle. The pilot house is up near the bows on top of the forward deck house, the arrangement being similar to the practice on the Great Lakes tankers, the steering being electrically controlled from the pilot house. To handle the boat in the sharp turns of the river, there are five rudders coupled up by a connecting rod and actuated by a hydro-electric steering system.

These boats are interesting as being the largest of their type ever designed for this shoal-draft work.

Effects of Sea Water on Concrete and Reinforcing Steel.—The results of an investigation by the Bureau of Standards, acting in co-operation with the Portland Cement Association, on the subject of the effect of sea water on concrete, tend to show that inferior concrete or concrete of which the surface skin has been impaired suffers serious disintegration when in contact with sea water. At the same time, doubt is expressed as to whether a thin layer of concrete can be relied upon to protect the steel reinforcement from corrosion. It is, therefore, recommended that the steel be protected by galvanization and by increasing the efficiency of the protected concrete by means of additional care in materials and workmanship and by a surface coating of waterproofing character.

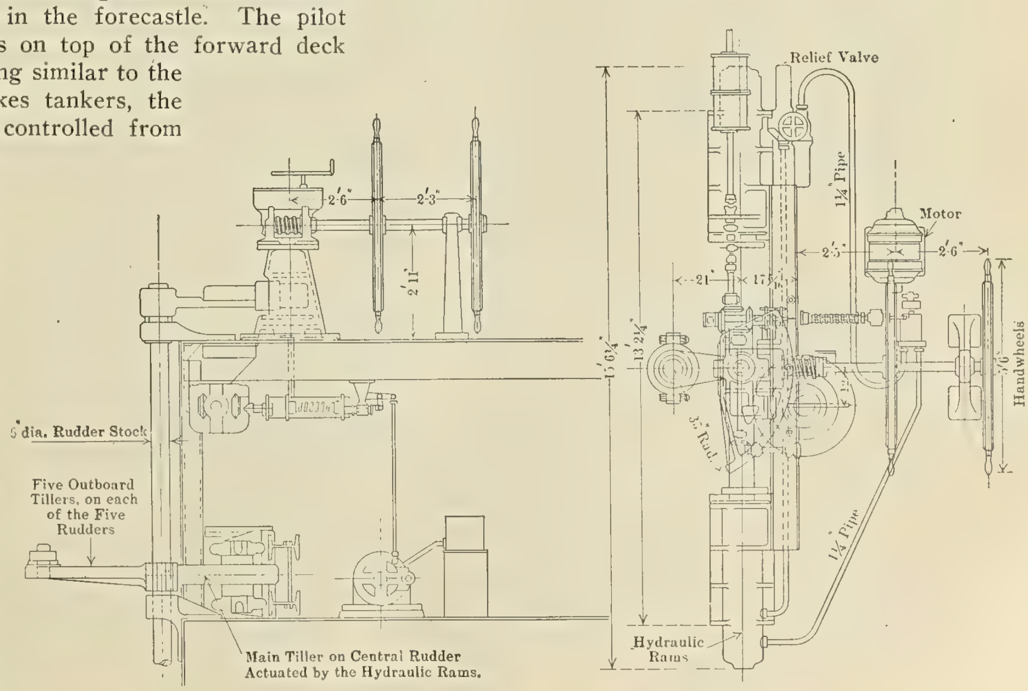


Fig. 6.—General Arrangement of Electro Hydraulic Steerer

5,000-TON REINFORCED CONCRETE SHIP

Building by San Francisco Ship Building Company

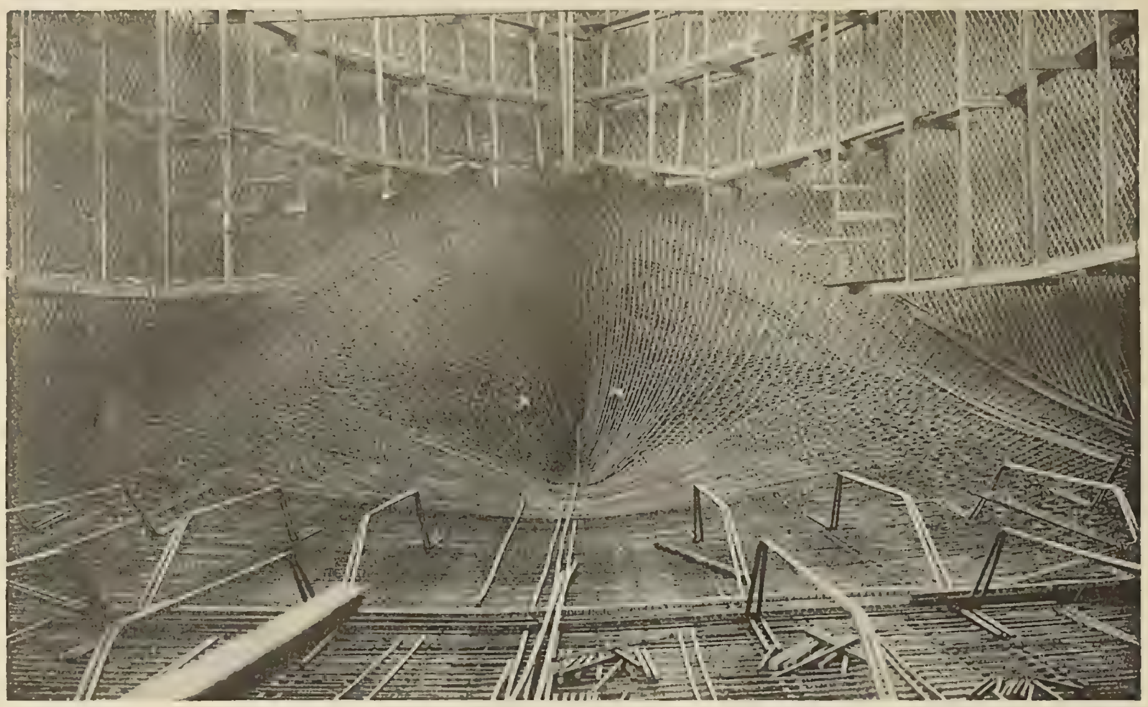


Fig. 1.—Interior View at Bow

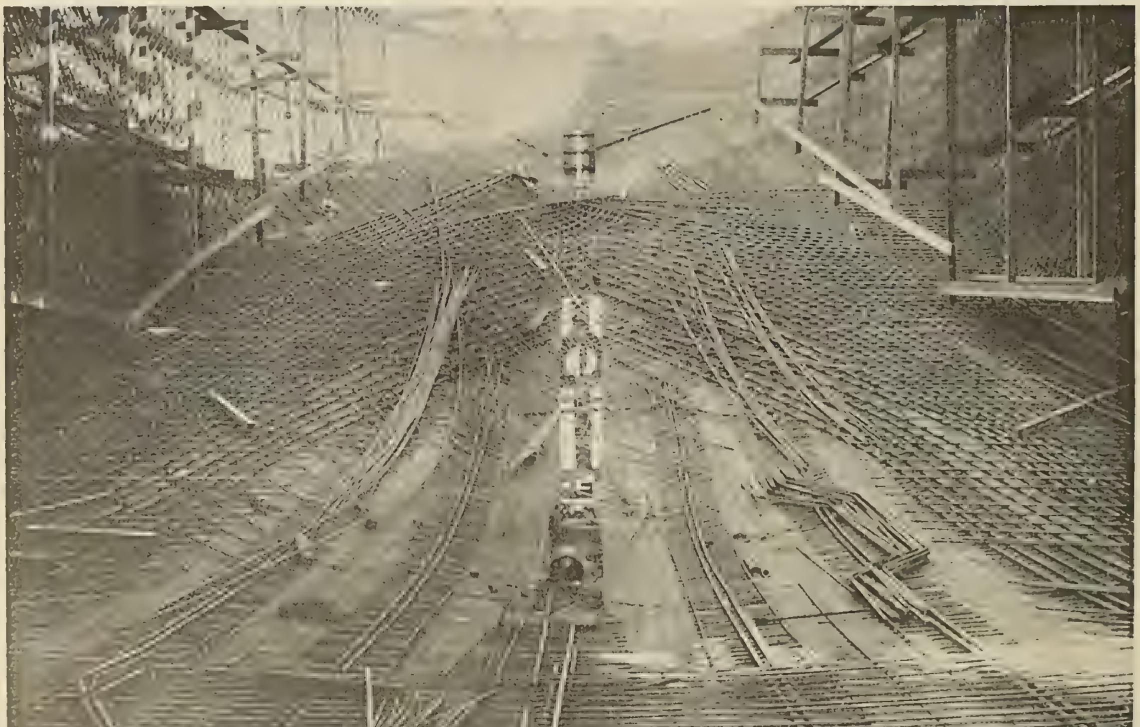


Fig. 2.—Interior View at Stern

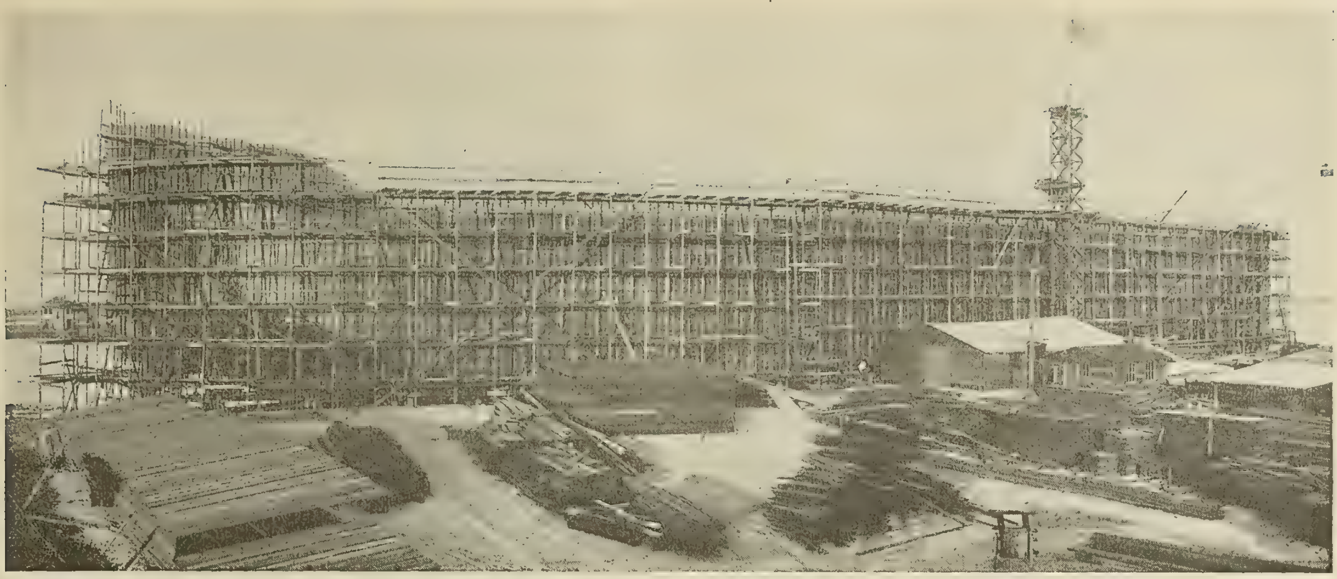


Fig. 3.—5,000-Ton Reinforced Concrete Vessel Under Construction at Redwood City, Cal.

5,000-Ton Reinforced Concrete Ship Building in California

ONE of the most daring experiments in concrete shipbuilding is the project now under way at Redwood City, Cal., where the San Francisco Ship Building Company is building a reinforced concrete freight steamship of 5,000 tons deadweight carrying capacity on a draft of 24 feet. The vessel is 320 feet long, 45 feet beam and 31 feet depth molded. She will be fitted with Scotch boilers and a triple expansion reciprocating engine of 1,750 horsepower designed to give the vessel a speed of 10 knots at sea. Tank storage space for fuel oil will be provided sufficient for thirty days' steaming at her designed speed.

Some idea of the size and details of construction of the vessel can be gained from the photographs reproduced herewith, which show the progress of construction about December 1. The officers of the San Francisco Ship Building Company, which is building the vessel, are: President, W. Leslie Comyn; vice-president, John Lawson, of Balfour, Guthrie & Co.; secretary, Kenneth MacDonald, of MacDonald & Kahn, and treasurer, George U. Hind. Messrs. Leslie Comyn and John Lawson, acting as an executive committee, exercise active management of the affairs of the company.

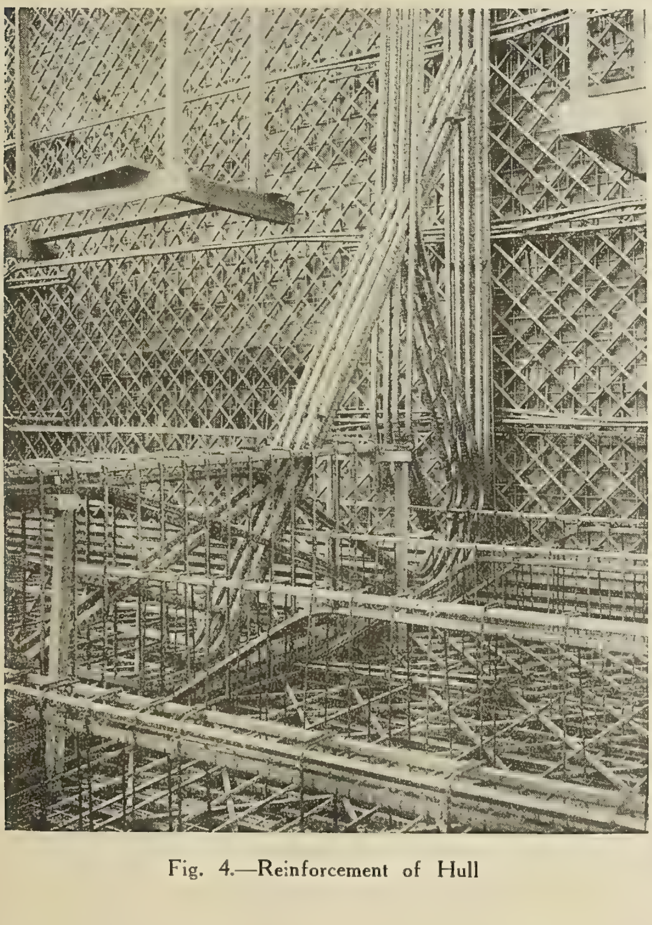


Fig. 4.—Reinforcement of Hull

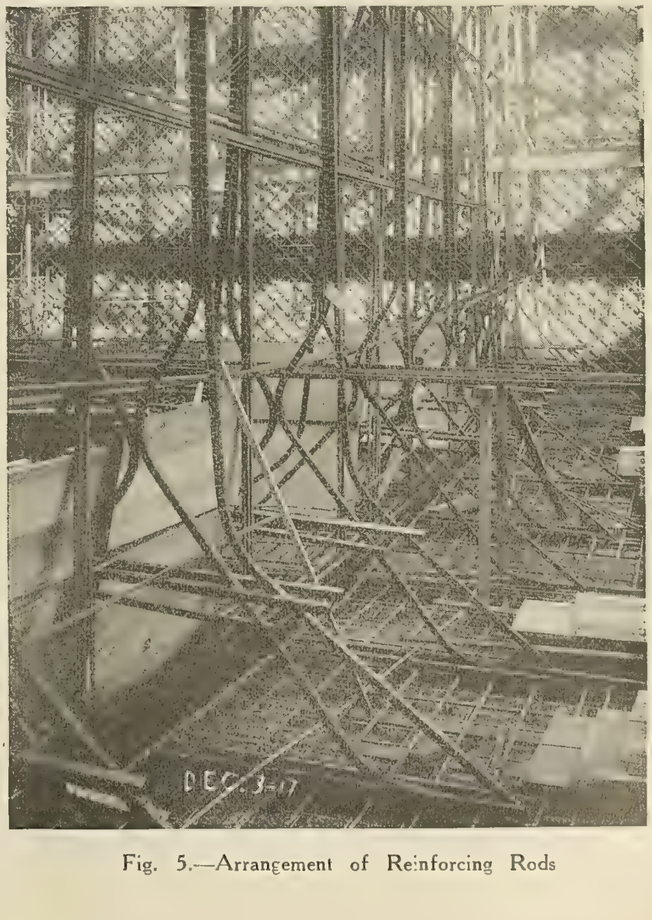


Fig. 5.—Arrangement of Reinforcing Rods

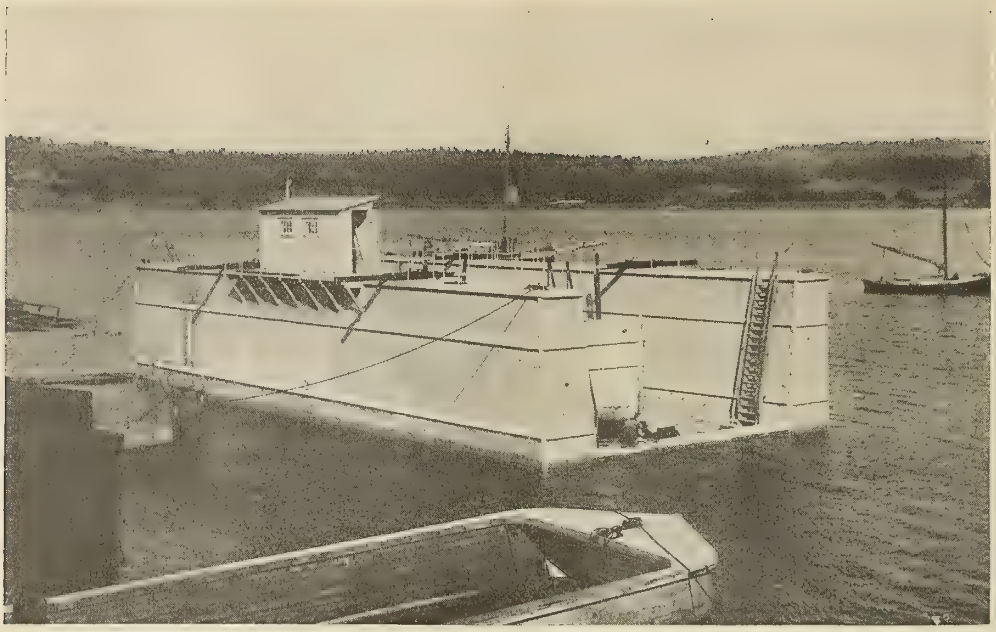


Fig. 1.—Concrete Floating Dry Dock with Concrete Lighter on Board

Ferro-Concrete Shipbuilding in Norway

Descriptions of Vessels Built by the Fougner Steel-Concrete Shipbuilding Company, of Christiania— Standardized Motorships of 360, 1,000 and 1,600 Tons

BY ROBERT G. SKERRETT

TO the Norwegians belongs the credit of having first produced a ferro-concrete, motor-driven, seagoing freighter. The *Namsenfjord,* for such is the name of the craft, is now actively engaged in coastwise traffic in Scandinavian waters, and reports from abroad disclose that she is in every way a satisfactory cargo-carrier within the limits of her displacement. Her deadweight capacity is 200 tons, and her propelling power is centered in a single 80-brake horsepower Bolinder oil engine. This suffices to drive her light at a speed of 8½ knots, or full laden at the rate of 7½ knots. The success of the *Namsenfjord* has blazed the way for a large business in granolithic motor-driven cargo vessels for her builders, the Fougner Steel-Concrete Shipbuilding Company, of Christiania, Norway. But, properly speaking, the *Namsenfjord* represents a distinct climax in naval architecture which had its beginning in a flotilla of lighters of reinforced concrete.

The managing director of the company, Engineer Nic. K. Fougner, is now in this country arranging for the establishment of a shipyard here, and because of this fact his achievements in Norway are of just so much more present interest to us. We say his achievements because the success of the building plant at Moss is undeniably due to his initiative and to his exceptionally broad familiarity with reinforced concrete and previous experience in the construction of a good-sized lighter built in Manila by him as an experiment some years ago. That barge was subsequently bought by a tobacco firm in the Philippine Islands, but Mr. Fougner did not dispose of it until he had subjected the craft to a series of convincing tests by

Fig. 2.—The *Namsenfjord* During Trial Trip

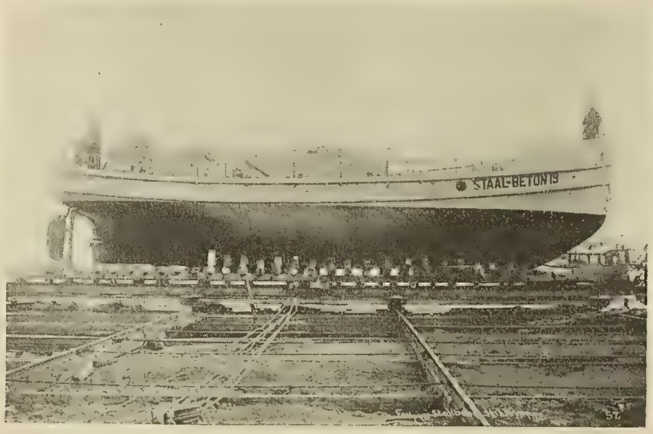


Fig. 3.—Ferro-Concrete Motor Tug Built by Fougner Company for Its Own Service

Fig. 4.—*Namsenfjord* Before Launching

which he demonstrated the correctness of his principles of construction, as well as the strength and sturdiness of the vessel.

Returning from the Far East just when Norway was beginning to feel the pinch of a shortage of structural steel for shipbuilding, he saw at once how his past work could be turned to good account, and lost no time in urging the organization of a company equipped to undertake the building of ferro-concrete seagoing ships. Conditions were made riper for consideration of his plan by reason of the ravages of German submarines. The Norwegians were sorely in need of additional bottoms, and native shipowners were keen for any sort of craft that would serve their purpose. Accordingly, the Fougner Steel-Concrete Shipbuilding Company, with Mr. Nic. K. Fougner as president, was organized in May of 1916, with a capital of substantially $130,000 (£26,600), and this was followed immediately by the establishment of a plant at Moss. Owing to the amount of business on hand and contracts pending, it became necessary early in 1917 to expand the shipyard and to increase the working capital to something like $700,000 (£143,500)—more than five times the original investment. It is suggestive of Norwegian enterprise and business acumen that the issue of stock in both instances was largely oversubscribed, and the biggest banking concern in the country stood squarely back of the enterprise. During the six months of actual production in 1916 the company paid a dividend of 10 percent to its shareholders.

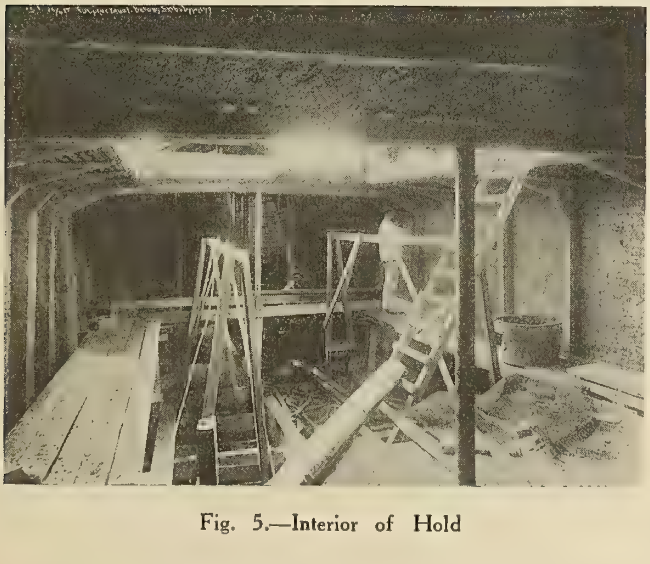


Fig. 5.—Interior of Hold

The first work undertaken consisted of orders for a number of steel-concrete lighters of 100 tons capacity; then followed the construction of a floating dock of reinforced concrete having a lifting capacity of 75 tons. This dock was built for a firm of yacht builders in Christiania, and has proved efficient and satisfactory in every particular since being turned over for service. While comparatively small as floating drydocks go, it established the practicability of using ferro-concrete in that department of marine activities. Other docks are in course of construction and plans for two, each capable of handling craft of 7,000 tons, have just been finished.

Next, the *Namsenfjord* was started. The time taken to turn her out was somewhat longer than at first contemplated, because Mr. Fougner felt that he had taken a big step forward and wanted to be sure that he was right in every essential. His method of construction differs radically from those urged or generally adopted by others engaged in naval architecture of this special class. As was the case with his lighter in Manila, his aim is to reduce the measure of steel material to a minimum and to use the very simplest of these—such as wire mesh, steel lath and bar stuff, all of which are comparatively easy to get, and call for only a very common class of labor to bend or form to suit the needs of any type of floating structure. In this way, steel plates, angles, etc., bent to shape and requiring riveting are entirely dispensed with.

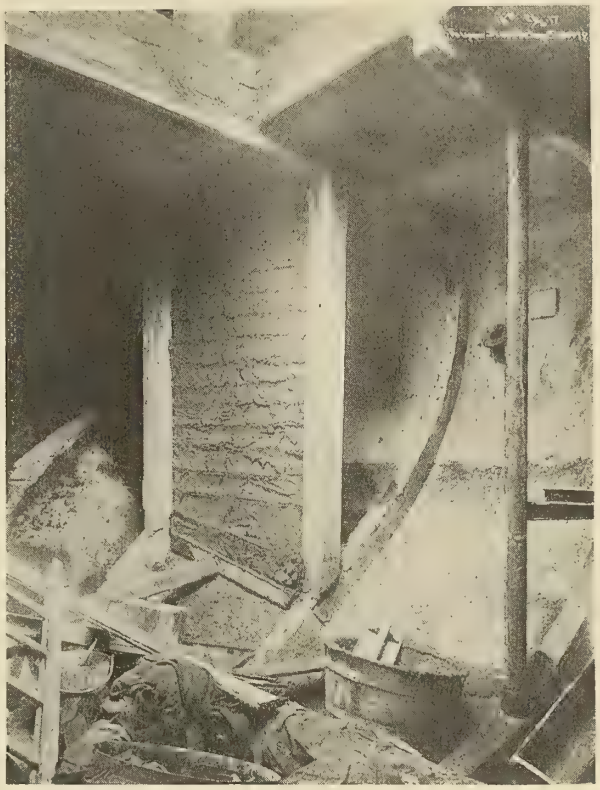


Fig. 6.—Interior of *Namsenfjord* During Construction, Showing First Wall of Side Water Tank

The wire mesh or steel lath are not intended to reinforce the granolithic mass—the bars alone do this—but the fabricated stuffs, any of which can be employed, merely serve as the two walls between which is cast the principal mass or shell of the craft. Because the wire mesh or the steel lath, as the case may be, is porous, enough of the concrete exudes to form knobs or lumps upon the two outer sur-

faces of the so-called mold walls. These projections provide keys, so to speak, for the finished exterior skin and the interior surfacing of the vessel. The deck beams and frames are stiffened by bar iron or steel ranging in thickness from a quarter of an inch to an inch and a quarter, and these are tied or linked to one another by hooked terminals. Deck stanchions, for convenience' sake, are made of piping filled with cement. It will thus be seen that the use of molds, as such are commonly understood, is done away with.

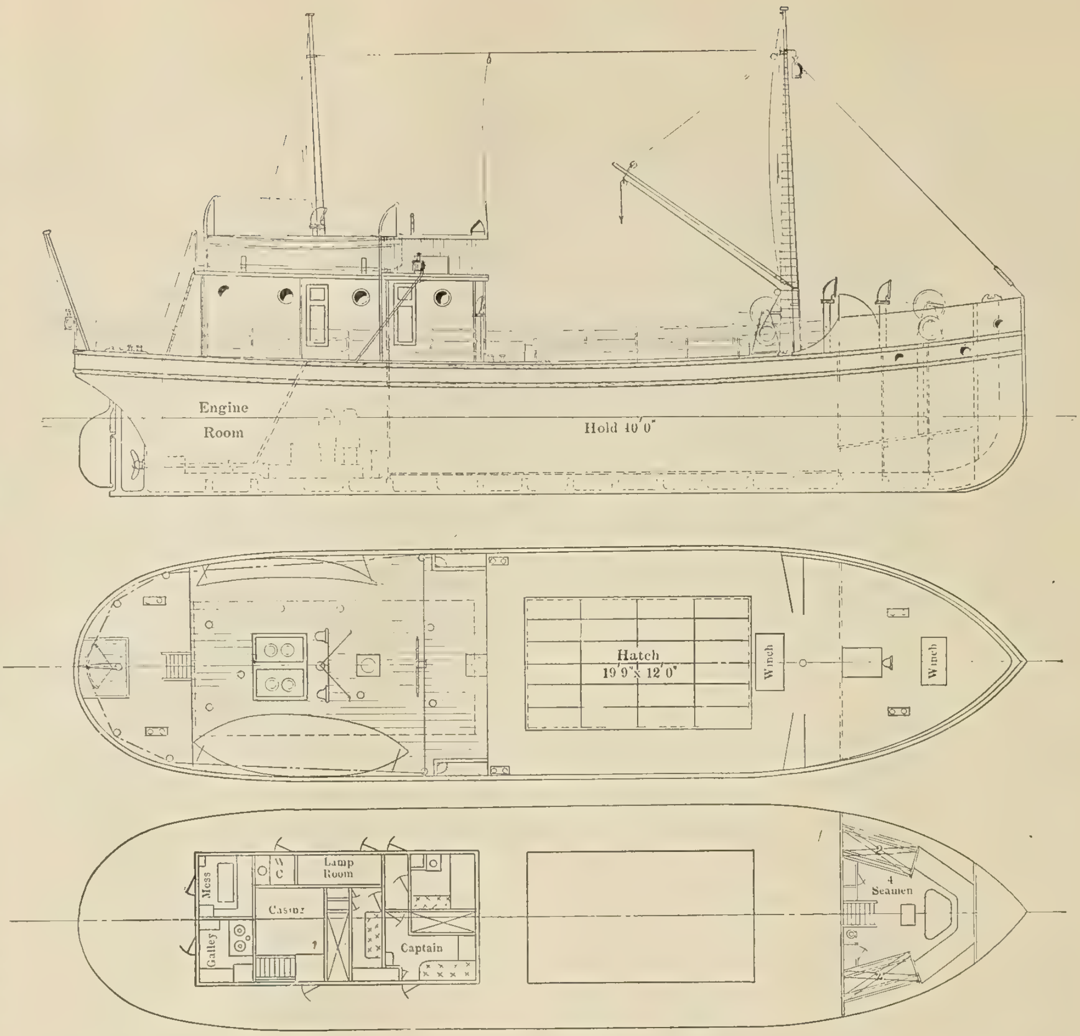


Fig. 7.—200-Ton Concrete Motorship; Length, 84 Feet; Beam, 20 Feet; Depth, 11 Feet 6 Inches

But apart from simplicity of getup and the need of only a small amount of steel material, Mr. Fougner gains much in structural strength by producing a floating body of uniform integrity. His steel work is completely buried in the granolithic mass, and perfect union, it is claimed, is insured. He does not try to attach a veneer of concrete to a fabricated framework of steel, and, therefore, the stresses of sea service cannot induce disunion, fracture and possibly structural collapse. Because of the method adopted by him, costs are necessarily very low by comparison with other types of ferro-concrete craft, and the time to build is likewise notably shortened. He is satisfied that when his yard here is ready for operations he will be able to turn out motor-driven ships of 3,000 and 4,000 tons deadweight capacity within a period of ninety days.

The question has repeatedly been asked, how will the concrete ship withstand the attack of salt water? And in answer we are told that it is possible to use a composition made from volcanic refuse, such as the ancient Romans did, and deposits of this stuff are to be found here in abundance. But Mr. Fougner has dealt with the problem in a more practical way: he waterproofs his concrete. For this purpose he has recourse to a colloidal ingredient which is added at the time of mixing the concrete. The colloid becomes an integral part of the mass, coating the surfaces of the pores left by the evaporation of the original water required in the preparation of the concrete. If moisture or water subsequently seek to penetrate, the colloid expands the instant it is acted upon by the moisture, and automatically forms a barrier capable of effectually arresting further progress on the part of the water. In short, Mr. Fougner says the outlying water or moisture is held at bay at the very surface of the mass. Therefore, the sea does not induce disintegration through the bursting stresses set up within concrete where sea water is brought in contact with cement containing free lime. To prevent the accumulation of marine growths, Mr. Fougner recommends the coating of the under-water surfaces with any suitable anti-fouling paint. He has found that these will adhere perfectly, and, in this way, wetted surfaces of low skin friction can be assured.

In the *Namsenfjord* the hull walls vary in thickness from 4 inches to 2½ inches—the latter being above water and along the bulwarks, while the heavier sections are naturally submerged and in the neighborhood of the bilges and bottom. This is in decided contrast with practice elsewhere in ferro-concrete construction. The *Namsenfjord* has longitudinals or inboard keelsons, and these are multiplied immediately beneath the oil engine foundation. Over here, it is Mr. Fougner's intention to employ the cement gun for the external coatings of the wire mesh or steel laths, but the final outside finish will be obtained by handwork.

Speaking of the engagements of his concern in Norway, he has lately announced: "Owing to the great demand for tonnage, our company has decided to standardize its output by centering upon motor-driven types of 360 tons, 1,000 tons and 1,600 tons. Aside from these, the yard at Moss has contracted for an ore-carrying ship of 4,000 tons, provided with twin screws actuated by large Diesel motors. The first of our 1,000-ton ships is to be launched

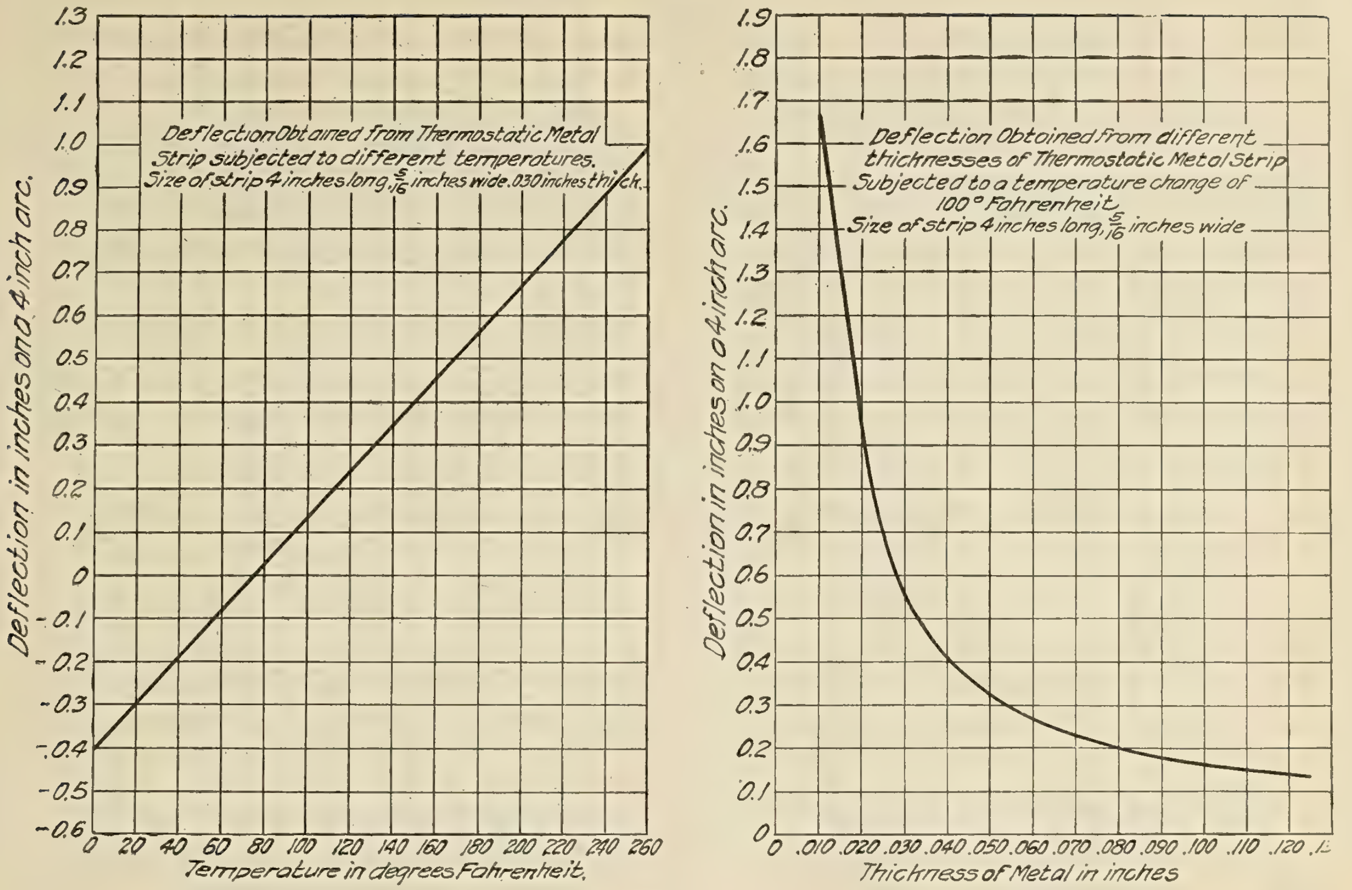


Fig. 1

this month (December), and the initial craft of 1,600 tons should be put overboard in January. I am satisfied that one of our bigger boats will cross the Atlantic in the course of the coming spring." In all, the Fougner firm has built or nearly finished a total of 20 vessels, and among this output is a lightship for the Norwegian government.

The British authorities have been keenly interested in the activities of the Moss plant, and the English government and Lloyds sent a commission to Norway to examine and to report upon the concrete vessels turned out by the Fougner Company. As a result, the *Namsenfjord* was given an official rating by Lloyds of A1. Even though we may hesitate to embark upon the building of ferro-concrete ships for transatlantic service, it is evident that enough has already been established by the *Namsenfjord* to show the practicability of craft of this sort for coastwise service and for duty upon our rivers and Great Lakes. We are desperately in need of bottoms of all sorts for domestic trade and water-borne transportation within continental limits. The scarcity of structural steel shapes and plates makes it apparent that the granolithic vessel may prove the readiest solution of the problem. We need bottoms that can be delivered quickly, and the shipowner wants boats that will endure; will cost as little as possible to maintain or repair; that will be fireproof, and which can be counted upon for rugged service.

Design for Concrete Ship.—In a recent report made by a joint committee from the American Concrete Institute and the Portland Cement Association, is given the design for a 2,000-ton self-propelled barge, 227 feet 6 inches long, 42 feet beam, of 3,675 tons displacement at a load draft of 18 feet. It is stated that the total cost of hull, exclusive of equipment, would be $126,000, or about $63 per ton deadweight.

Thermostatic Metal Developed by General Electric Company to Control Appliances by Heat or Cold Applicable to Marine Work

The development of the G. E. thermostatic metal by the General Electric Company, Schenectady, N. Y., has put a new means for warning of undue heat or cold and prompt regulation of the temperature changes into the hands of naval architects, naval constructors and navigators.

This metal is so susceptible to temperature changes that, according to the manufacturers, a difference of one degree higher or lower will tend to curve or straighten it and always to the same extent. It can be used for temperatures as high as 500 degrees F. By curvature or

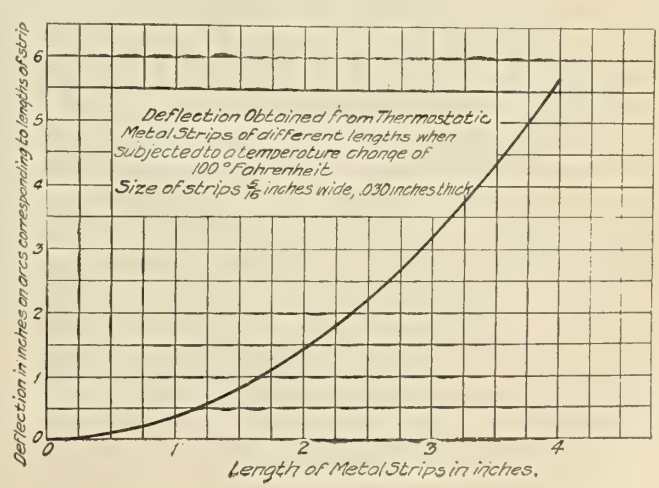


Fig. 2

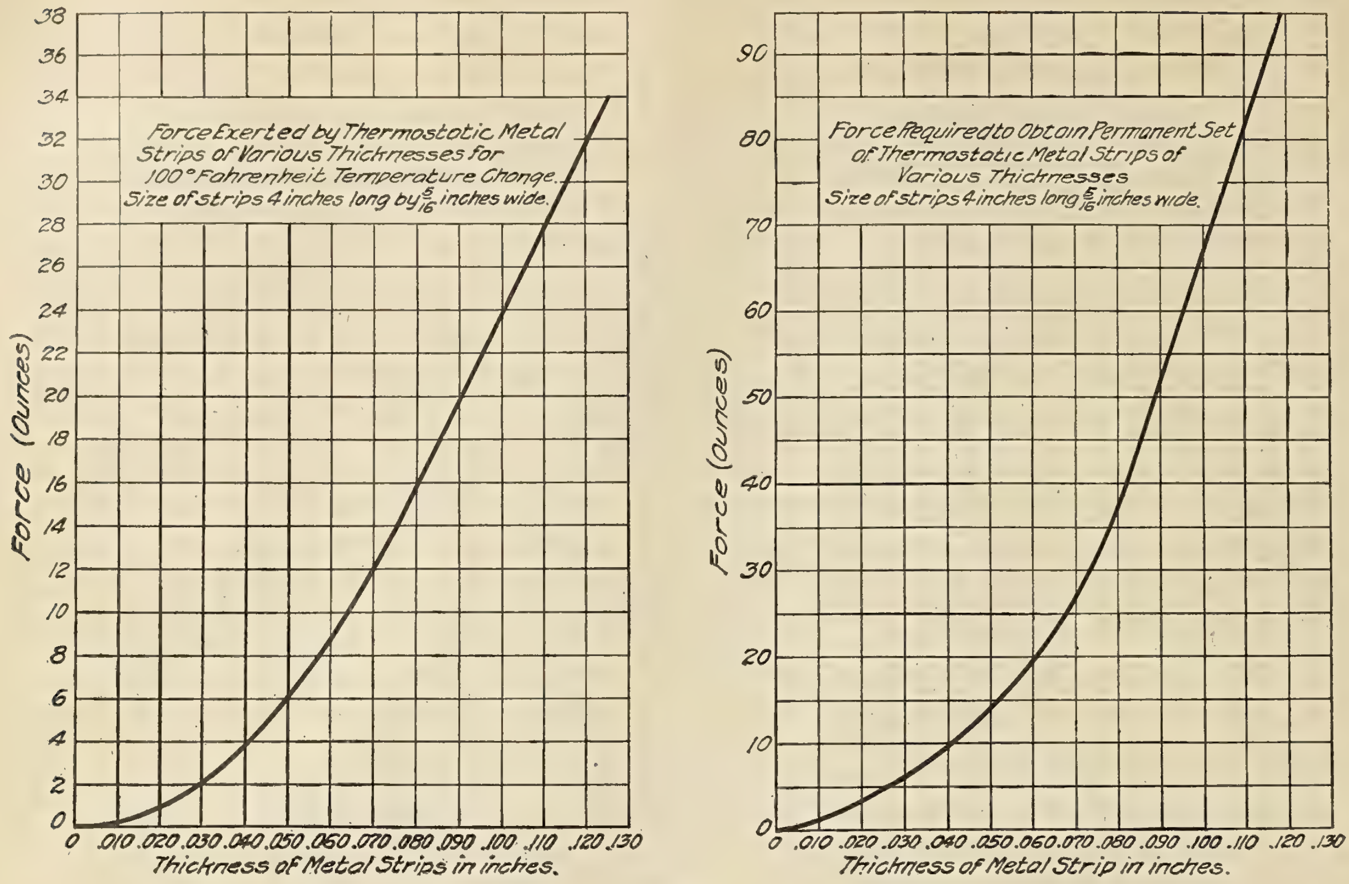


Fig. 3

straightening it will make and break electrical contacts and even exert a force.

Its present use as a means of temperature regulation in furnaces and refrigerators, together with its non-corrosive characteristics, suggests its possibilities in marine service. As a result of its responsiveness to change of temperature and the mechanical force developed, this metal is used to actuate various mechanisms which tend to neutralize either the temperature change or its effect upon devices.

G-E thermostatic metal consists of two strong non-corrosive metals possessing a wide difference in coefficients of expansion, the widest difference possible for any known stable combination of metals. These two metals are firmly attached to each other throughout their entire length, so that there is absolutely no slip of the one upon the other. Thermostatic metal can be cut, stamped or pressed into practically any shape, and when annealed will have all its original inherent qualities; moreover, it will not deteriorate nor take permanent set under applications of heat or force within definite practical limits. The metal is manufactured in various standard thicknesses ranging from 0.25 to 0.015 inch, maximum width of 6 inches and maximum length of 36 inches.

The deflection per degree temperature change besides being quite considerable, as shown by the right-hand curve in Fig. 1, is a constant for any definite piece of the metal, as will be seen by referring to the curve in Fig. 2. Since a definite and considerable opposing force is necessary to cause the metal to take permanent set (see right-hand curve, Fig. 3), the metal can be depended upon when used in devices where extreme accuracy is required.

If the curving of thermostatic metal on heating or cooling is opposed, the metal will produce a mechanical force (see left-hand curve, Fig. 3), which is limited only by the force required to produce permanent set, right-hand curve (Fig. 3). For example, the left-hand curve (Fig. 3) shows that a piece of thermostatic metal 1/10 inch thick, 5/16 inch wide and 4 inches long will exert a force of 24 ounces (1½ pounds) on being restrained from bending when subjected to a temperature of change of 100 degrees F. This curve illustrates the law that the force by this metal varies as the square of the thickness, directly as the width and as the square of the temperature.

Other curves given illustrate the deflection resulting as one of the two dimensions, length or thickness, varies with a definite change in temperature. The width of the piece has no influence on the deflection resulting from temperature change. From these curves it will be found that the deflection for any given temperature change varies as the square of the length of the piece of thermostatic metal and inversely as the thickness of the piece. As previously pointed out, the deflection of any piece of metal varies directly as the temperature change.

G-E thermostatic metal is used in the products of many different industries, owing to the fact that it can be successfully worked into different shapes and forms. In some of its applications it is used to actuate mechanisms directly by means of the force developed within itself when its tendency toward assuming a curved shape is restrained. In other applications it is used to close and open the contacts of electrical circuits by means of which various devices are operated.

The reliability of this metal has merited its use in thermometers and has gained consideration for it as a compensating device in balances, and it is but a step forward to see it used in the proverbially accurate ship's chronometer.

Cargo Ship Lines of Simple Form

Paper Read Before Naval Architects' Society Describing Results of Tests of Models of Simplified Form at Washington

BY NAVAL CONSTRUCTOR WILLIAM MC ENTEE, U. S. N.

The recent wide discussion and general interest in possibilities of standard cargo ships to be built in large numbers from standard plans has naturally brought into prominence the matter of simplifying the form of ships.

The tendency in ship construction for a long period has been in the direction of simplification. In general, the simplification of form requires the use of plain surfaces at right angles instead of curved surfaces wherever possible. Where curvature is unavoidable, the simplest of curves, the circle, should be used. All curvature should be in one direction only; that is, surfaces of double curvature should be avoided so far as possible.

These considerations lead, in the forming of a ship, to the adoption of a midship section formed by two vertical lines and a horizontal line at the bottom, the corners or bilges being rounded off by circles of suitable radius. The sides and bottom of the ship will be flat surfaces carrying the full midship section well forward and aft, making what is known as the parallel middle body extend as far as possible without excessive increase in resistance. Forward, where it is necessary to fine the lines to form an entrance, it can be done by gradually decreasing the width of the ship, keeping the bottom flat and the sides vertical, the bilge being formed by a quarter circle of constant radius equal to that used for the middle part of the vessel.

Aft, the possibilities of simplification are limited by the necessity for providing space for the propellers. Two different methods of simplifying the after body are shown in Model 1,997 and Model 2,056, Figs. 1 and 2. The general result in these forms is to make the waterline somewhat wider and place the displacement higher up. This arrangement seems favorable from both the resistance and the propulsion standpoints, but may have disadvantages as regard seagoing qualities.

In the present investigation an attempt has been made to show how the power required for propulsion is affected by simplification of the lines of three different types of cargo vessels.

TABLE I—DIMENSIONS

Model Number.	Type.	Length, Feet.	Beam, Feet.	Draft Feet.	Displacement, Tons.	Speed, Knots.	E. H. P.	Longitudinal Coefficient.	Midship Section Coefficient.	Parallel Middle Body, Percent.
1978	Oil fuel barge, conventional form	160	25	9 25	830	6	34.4	.80	.98	30
1997	Oil fuel barge, simplified lines	160	25	9.25	850	6	35.6	.82	.98	40
2023	400-foot freighter, conventional form	400	57.3	26	13,137	10.5	1080	.788	.987	33.4
2056	400-foot freighter, simplified lines	400	57.3	26	13,137	10.5	1120	.788	.987	33.4
Series*	500-foot cargo vessel, conventional form	500	73.6	26.77	20,000	14	3440	.74	.96	30
2045	500-foot cargo vessel, simplified lines	500	72.5	26.375	20,000	14	3290	.74	.989	30
1121	U. S. Collier Neptune	520	65	27.5	19,340	14	3460	.738	.983	25

* Estimated from Experimental Model Basin's Parallel Middle Body Series (No. 26).

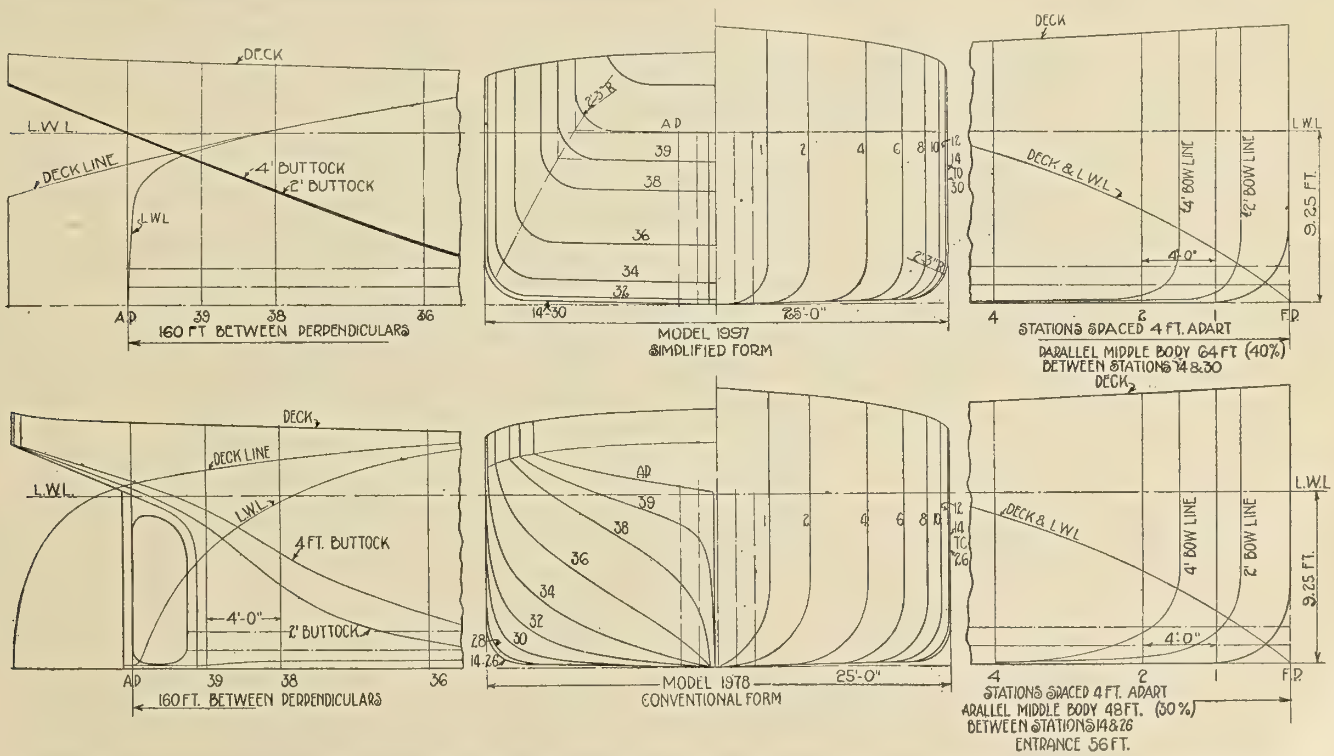


Fig. 1.—Lines of Models Nos. 1978 and 1997, Representing 160-Foot by 25-Foot by 9.25-Foot by 830-Ton Fuel Oil Barges of Conventional Form and of Simplified Lines

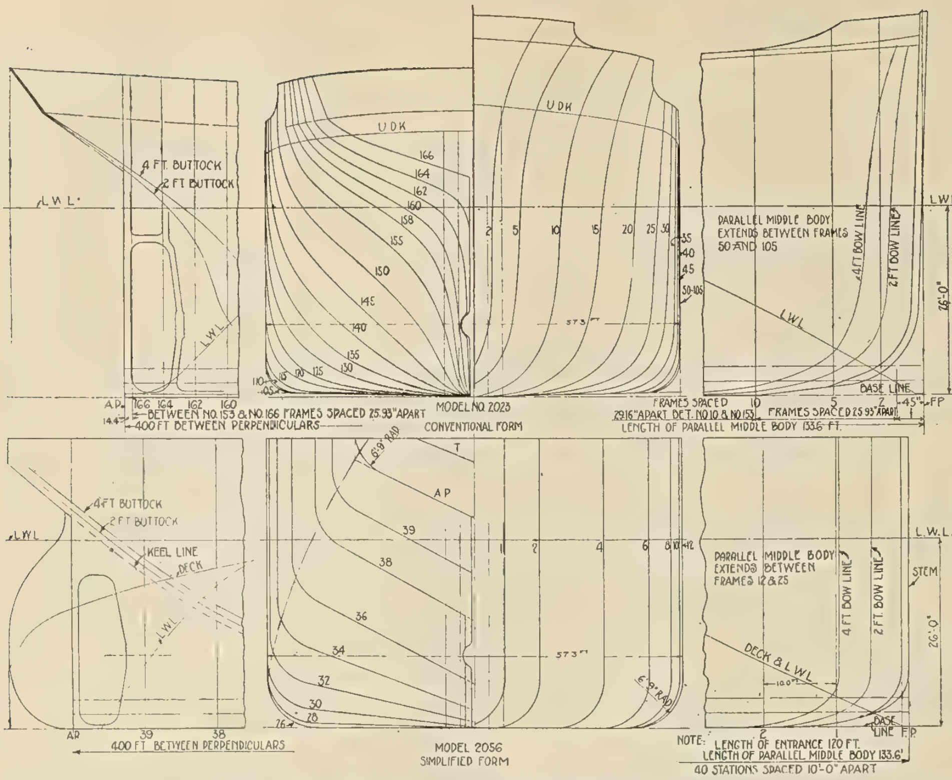


Fig. 2.—Lines of Models Nos. 2023 and 2056, Representing 400-Foot by 57.3-Foot by 26-Foot by 13,137-Ton Cargo Ships of Conventional Form and of Simplified Lines

Models 1,978 and 1,997, lines of which are shown on Fig. 1, are models of a 160-foot oil fuel barge of 830 and 850 tons, respectively. Through a slight error in making Model 1,997, the cylindrical or prismatic coefficient and displacement are somewhat larger than for the model with which it is compared; that is, No. 1,978 of conventional form. The effective horsepower curves for the estimated power are shown in Fig. 4. It will be seen that the curves are very nearly the same, the simplified form requiring about 35 effective horsepower at 6 knots, as compared with 34 for the conventional form, due to the larger cylindrical coefficient of the simplified form.

Models 2,023 and 2,056, lines of which are shown in Fig. 2, are of a 400-foot, 10.5-knot cargo ship of the usual

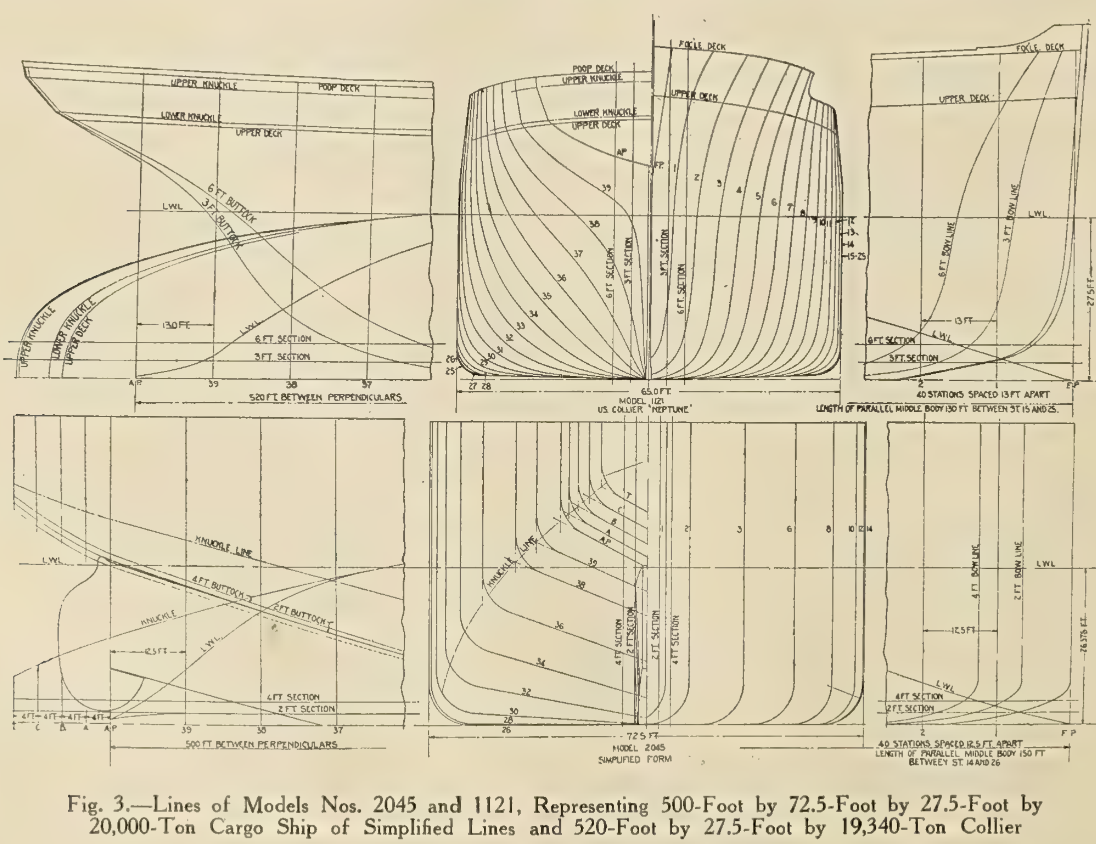
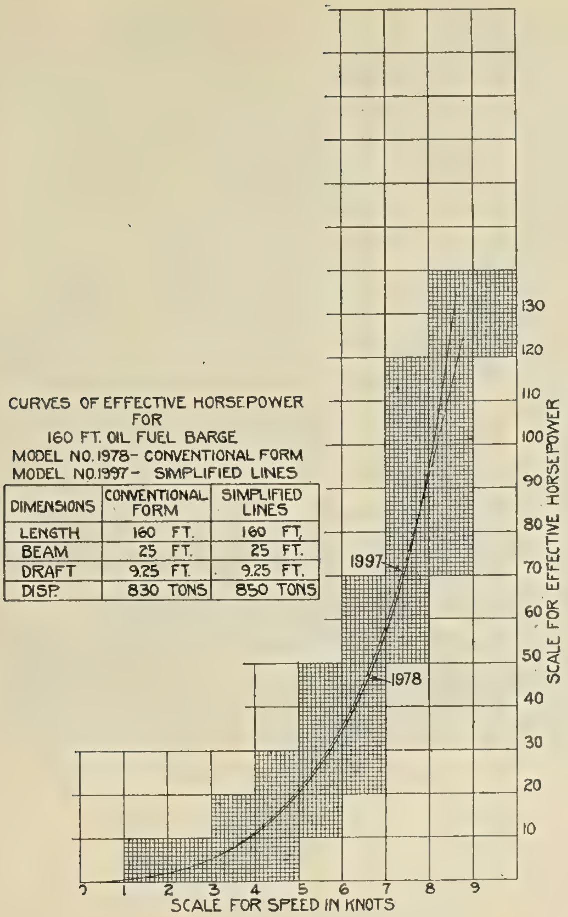
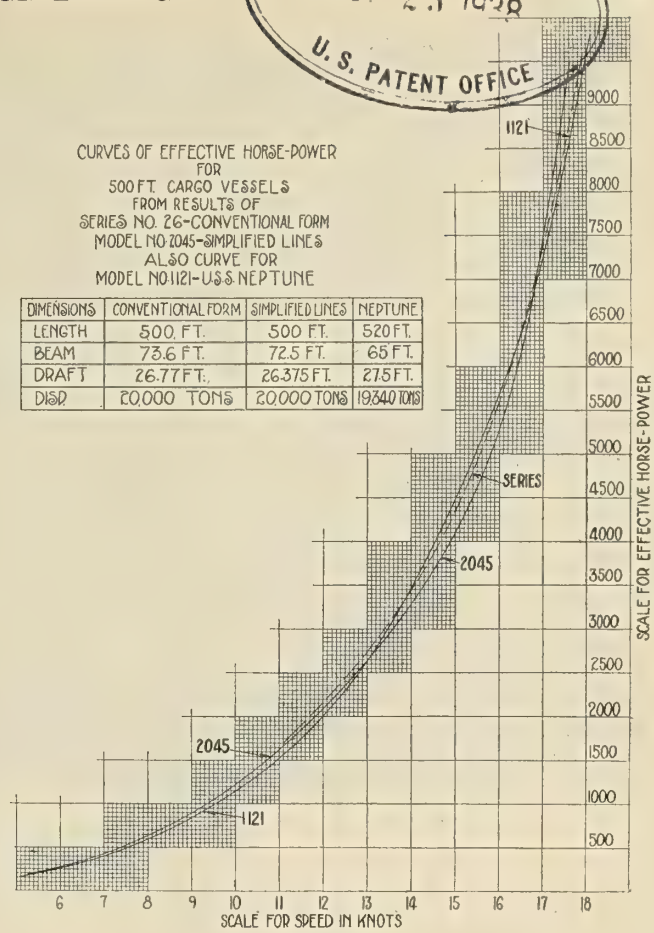


Fig. 3.—Lines of Models Nos. 2045 and 1121, Representing 500-Foot by 72.5-Foot by 27.5-Foot by 20,000-Ton Cargo Ship of Simplified Lines and 520-Foot by 27.5-Foot by 19,340-Ton Collier



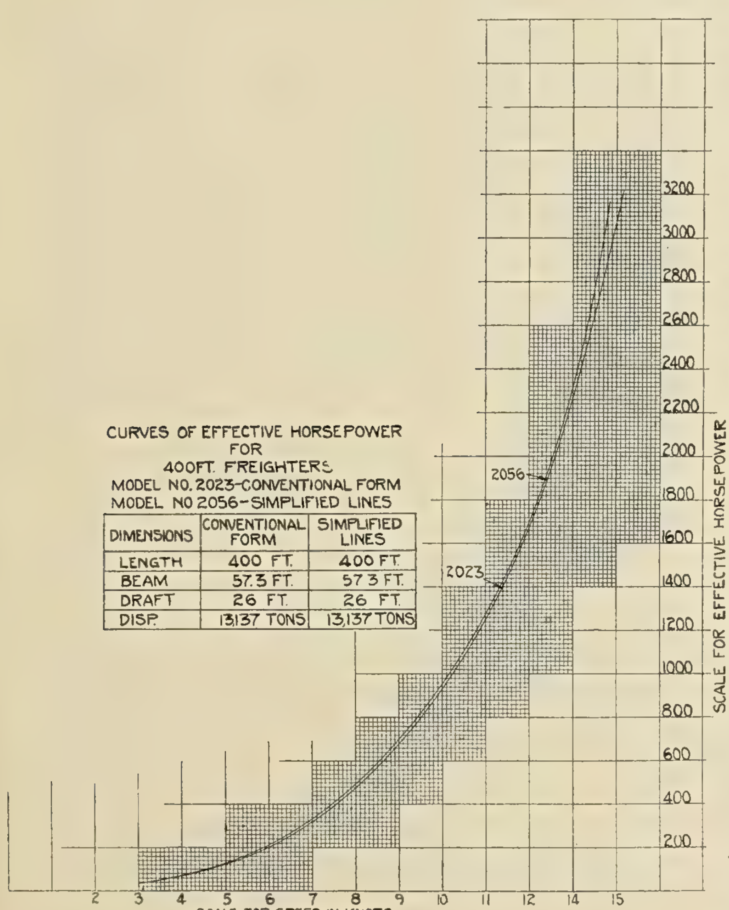
DIMENSIONS	CONVENTIONAL FORM	SIMPLIFIED LINES
LENGTH	160 FT.	160 FT.
BEAM	25 FT.	25 FT.
DRAFT	9.25 FT.	9.25 FT.
DISP.	830 TONS	850 TONS

Fig. 4



DIMENSIONS	CONVENTIONAL FORM	SIMPLIFIED LINES	NEPTUNE
LENGTH	500 FT.	500 FT.	520 FT.
BEAM	73.6 FT.	72.5 FT.	65 FT.
DRAFT	26.77 FT.	26.375 FT.	27.5 FT.
DISP.	20,000 TONS	20,000 TONS	19,340 TONS

Fig. 6



DIMENSIONS	CONVENTIONAL FORM	SIMPLIFIED LINES
LENGTH	400 FT.	400 FT.
BEAM	57.3 FT.	57.3 FT.
DRAFT	26 FT.	26 FT.
DISP.	13,137 TONS	13,137 TONS

Fig. 5

single-screw type. At 10.5 knots it will be seen from the power curves, shown in Fig. 5, that the simplified form requires something less than 2 percent greater effective horsepower than for the conventional form. As Model 2,023 gave results which were considered to be good for this type of vessel, it follows that the simplified form, Model 2,056, would require appreciably less power than many cargo ships of conventional form in this general class now built and building.

In Fig. 3 are shown the lines of the United States collier *Neptune,* and of a 500-foot cargo vessel of simplified lines and somewhat greater displacement. The effective horsepower curves for these two models are given in Fig. 6. On this plate, also, is shown the estimated effective horsepower curve for a 500-foot ship of conventional form having the same displacement, 20,000 tons, and the same cylindrical or prismatic coefficient, .74. This latter curve is estimated from tests of one of a series of models of conventional form. The simplified form requires a little more power than the latter for speeds up to 13 knots. From that up to a speed of about 17 knots, the simplified form is the better, the advantage at a speed of 15 knots being in the neighborhood of 7 percent. On the same sheet it will be seen that the *Neptune,* which is of the conventional form, but 520 feet in length and of somewhat less displacement—that is, 19,340 tons—requires in general more power than the simplified lines.

The main dimensions of the models, or rather of the ships represented by them, are given in Table I.

In general, it appears to be safe to conclude that cargo vessels can be built of simplified lines which will give practically as good results from the resistance standpoint as those built from the present conventional lines. If propulsive efficiency is also taken into account, it is believed that the simplified form will have, at least in certain cases, advantages over the present type.

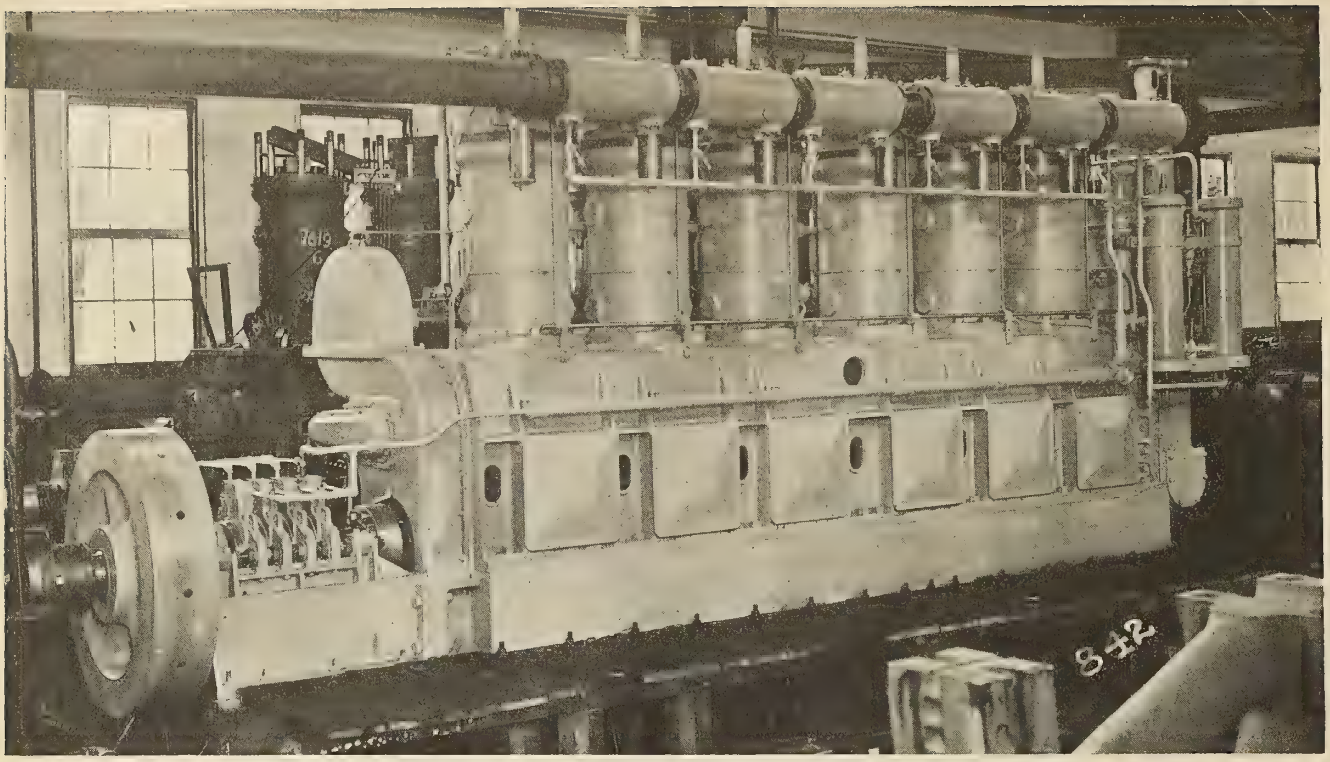


Fig. 1.—500-Horsepower Unit, McIntosh & Seymour Marine Diesel Engine

McIntosh & Seymour Marine Diesel Engines

Description of New, Heavy Duty, Four Cycle Type, Marine Diesel Engine Manufactured by McIntosh & Seymour Corporation, Auburn, N. Y.

THERE are now being shipped to the Pacific Coast a number of 500 horsepower heavy duty marine Diesel type oil engines, built by the McIntosh & Seymour Corporation, of Auburn, N. Y.

The engine has six cylinders and is of the four-cycle type, single acting and is directly reversible. The general arrangement of the engine is well shown in the various illustrations, and, as can be seen, the framing of these smaller sized units is of the box type, provision having been made for convenient access to all the working parts. The form of framing is such as to give the greatest stiffness with minimum weight, and reduces the size of the base, at the same time decreasing the weight of the engine.

Air Compressor

The air for atomizing the fuel for the working cylinders, also that required for maneuvering, is furnished by a three-stage compressor, located at the forward end of the engine and direct driven from the engine. In cases where the engines are used for twin screw vessels this compressor is of ample size to supply atomizing and maneuvering air for both engines in case of necessity. It is substantially built with intercoolers and aftercoolers arranged according to the most modern practice. The valves and cages are all accessible and removable as a unit, making their removal or renewal a simple operation.

Both the standard horseshoe marine thrust bearing and the "Kingsbury" thrust bearing are used by this corporation for their marine engines. The thrust bearing is carried in a substantial base, bolted securely and doweled to the engine base, and contains a large bearing located at its after end, making it possible to carry the flywheel overhung, as indicated in the illustrations. The main working cylinders are bolted to the top of the engine frame and are of a simple design provided with removable liners. The heads are separate from the cylinder, each containing an inlet exhaust, fuel and starting valve. The gear for operating these valves is clearly shown in the illustrations.

The cam shaft, as can readily be seen, is carried in a housing bolted to the engine framing, and driven by spur gears from the after end of the crank shaft. From the forward end of the cam shaft a fuel pump and speed limiting governor is driven.

Maneuvering Gear

The maneuvering gear, which can easily be understood from a careful study of the illustrations, is located at the forward end of the engine. The maneuvering, which is accomplished by simple operations, is all done in the proper sequence, due to the interlocking features of this device, thereby preventing the operator from damaging this equipment in any way due to the misunderstanding of its functions. The supply of fuel and the consequent control of the ship's speed is accomplished by one single lever.

There is arranged a control lever, within easy reach of the operator, which is devised to relieve the cylinders of any pressure, and when brought into operation automatically shuts off the atomizing air when these relief valves are open.

Lubrication

The lubrication for the working cylinders, piston pins and compressor is effected by the use of a Richardson Phenix force feed lubricator, driven by gears and suitably timed, so that the lubricating oil is delivered to the various parts during that portion of the cycle that is most beneficial. The oil from the crank pins, main bearings and other journals is supplied from a gravity system, through gang oilers conveniently located. As the engine is entirely enclosed, the base having a bottom cast in, the oil is all collected in the base, and is returned through a filter to the bearings by gravity. A small pump driven from the cam shaft is arranged for automatically handling this oil.

Preparation of the Fuel

The principal features of this engine are the thorough preparation of the fuel, which has proven to be very effective both on the marine and stationary engines built by the McIntosh & Seymour Corporation. The thorough cooling of the upper part of the liner and cylinder head is also a point not to be overlooked in the selection of an engine for continuous marine service. The cooling system on this engine is so arranged that salt water can be used for cooling purposes without coming in contact with steel studs or any parts liable to be affected by it. It has the same effective cooling, however, as on stationary engines and has the same even flow and proper circulation through the head.

In the shop tests of these engines, they are subjected to a continuous run, such as would be the equivalent of a normal ocean voyage, during which period numerous maneuvering trials are made. The average time consumed from the full speed ahead to full speed astern for fifty maneuvers is eight seconds. Very likely this time could be reduced, when the engine has become thoroughly limbered up and the operators are perfectly skilled in the handling of same. The fuel consumption is a trifle over .4 pound of fuel oil per brake horsepower hour, when operated at rated speed and rated load. It has been demonstrated that these engines are capable of a reduction in speed of 60 percent.

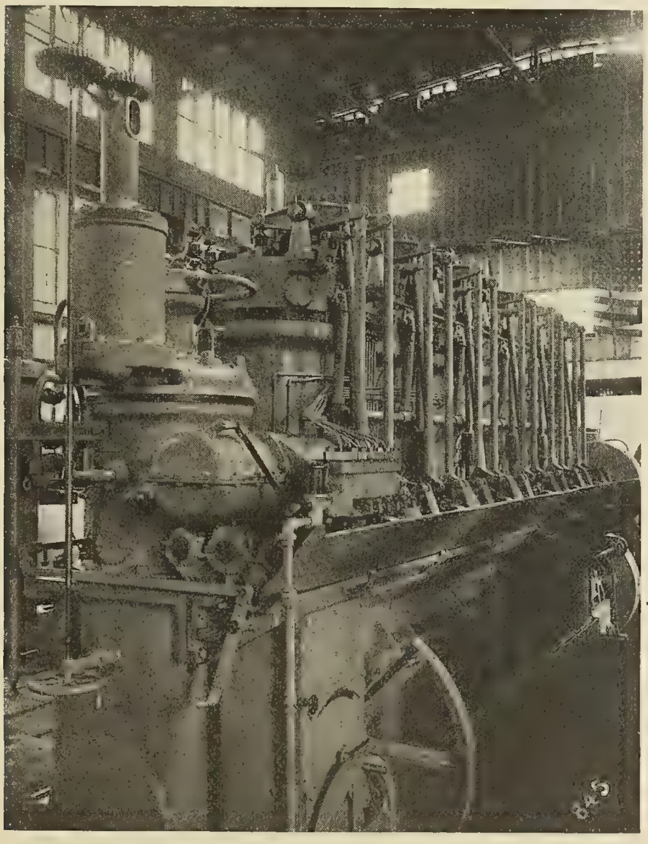


Fig. 2.—View Showing Valve Operating Gear and Air Compressor

The McIntosh & Seymour Corporation have been extremely liberal in the selection of all the accessories and equipment that they furnish with these engines, and one evidence of this fact is that the maneuvering tanks furnished with the engines, in which they carry 300 pounds, are of sufficient size to start these engines forty-four times, the minimum starting pressure being 80 pounds. The average reduction in pressure in this maneuvering tank, per start, is for each maneuver.

The standard sizes in which these engines are built by the McIntosh & Seymour Corporation are: 300 brake horsepower, 500 brake horsepower, 750 brake horsepower and 1,350 brake horsepower.

Progress in the Development of Freight Handling

No other subject in connection with transportation is receiving more attention and expert investigation at the present time than the economical handling of package freight. The management of practically all of the leading railroads and steamship companies throughout the country have already delegated their most experienced engineers to the task of finding a solution of this problem.

It is interesting to note that while they are all working more or less independently, they are arriving at one common conclusion as to the fundamentals which will ultimately be the basis upon which the most economical method will be determined.

Most Economical Method

It is safe to state, and obviously so, that each loading and unloading of freight, while being conveyed on trucks from one point to another, promotes the tendency to increased cost per ton with the added factor of delay. It has been generally conceded by experts that the greatest economy can be obtained by keeping the freight on the same wheels or trucks until it reaches its ultimate destination—that is, from the point where the movement originates to the point where it is to be put in cars or storage.

While the same fundamentals apply in every case, there cannot be any fixed detailed arrangement that would suit all conditions. The details in each case involve the layout and spacing of tracks, arrangement and width of platforms, method of checking, weighing, etc., together with the selection of the mechanical equipment, which plays a most important part.

Fundamental Principles

In the larger terminals the traffic system involving the movement of trucks is also a very important consideration. There are a few principles, however, that apply in all cases and unless these fundamentals are fully recognized the desired economy need not be expected. As heretofore mentioned, the maximum economy can only be expected when moving freight from the starting point to its destination, by keeping it on its same set of wheels. This statement being accepted, the next consideration is the type of trucks or means for conveying from one point to another.

It has in the past been a common belief of many of

those actively engaged in or having supervision over the transfer of freight that the well-known two-wheel type of truck is the most practical for the purpose. As a result of more recent exhaustive investigations, it is now conceded that this type of truck must be discarded for general trucking before any appreciable reduction in cost is possible. We believe that this statement is now accepted by engineers studying this subject, as well as by those directly in charge of freight handling.

Four-Wheel Truck Displacing Two-Wheel Type

It is a fact that economy in this sense means increased tonnage per man, and four-wheel trucks are rapidly displacing those of the two-wheel type as a means of accomplishing this result. Many of the recognized types of such trucks are so constructed that one man can move 2,000 to 3,000 pounds, as against an average of 400 to 600 pounds on a truck of the two-wheel type.

The rolling surface of the platforms on which such trucks are to be used must necessarily be good, and this has a very important bearing on the movement of such trucks. This particular subject has never received the amount of attention it deserves, although one of our leading Eastern railroads recognizes its importance and is making a very careful investigation and study of the matter.

Most of the modern terminals, warehouses and transfer stations in our larger cities are of such size that trucking distance is also a very important consideration, and a further increase in the tonnage per man is possible by employing four-wheel trucks, using them as trailers and hauling them with storage battery tractors in trains of several trucks. By an ingenious arrangement the trucks are made to trail in the path of the tractor.

Investigation has also brought the fact to our attention that further efficiency may be obtained by using the trucks as distributing stations and storage bins, to be moved only when they have been loaded up to their maximum capacity.

Vertical Movement of Freight

So far consideration has been given only to the economical horizontal movement of freight. An additional problem is involved in the vertical movement of freight due to the rapidly growing necessity for the double deck or two-story pier or freight house. The advantages of this type of terminal are many and are very ably set forth in Mr. E. H. Lee's notes on L. C. L. freight houses as published in a bulletin of the American Railway Engineering Association, March, 1914. There are many cases where double decking of freight terminals is not a matter of choice, but becomes compulsory, due to local conditions and requirements.

Freight Kept Intact on Trucks

After a careful study of the requirements of the double deck terminal, one of the leading elevator manufacturers, in co-operation with railroad engineers, has developed two different types of apparatus to take care of this vertical movement. One of the prime requisites of apparatus of this character is to maintain to as great a degree as possible the economy thus far obtained by the use of four-wheel trucks and tractors when moving freight in the horizontal direction, and to carry out the original basic principle and accepted fact that the freight must not be reloaded, but kept intact on the same wheels or trucks until it reaches its destination. The apparatus must, in a sense, be "operatorless" to further reduce the expense of elevating the freight, and must also be of the highest grade to insure reliability of operation and low cost of maintenance.

Inclined Elevators

One type of apparatus is known as the inclined elevator and is designed to handle two-wheel trucks, also four-wheel trucks, either singly or in trains, and with or without tractors. This type of apparatus permits of the continuous movement of trucks from the starting point, along the horizontal, up the incline and along the horizontal at the other elevel to its final destination or unloading point, after which the empty truck is returned to the loading level by way of the nearest inclined elevator which is operating in the descending direction. As the inclined elevator is a continuous carrier, it has enormous carrying capacity.

Operatorless Vertical Elevator

The other type of apparatus is the electric elevator designed for vertical travel, and owing to the ingenious devices for starting and stopping the elevator and for the automatic opening and closing of gates or doors, it has been justly termed the "operatorless elevator." One of the important features of this elevator as developed for this class of service is the automatic leveling device which registers the platform accurately with the landing at all times under all conditions of loading. This is a requirement that is absolutely essential to the successful handling of trucks in their vertical travel, as the rolling of these loaded trucks on and off the elevator platform must be accomplished with the minimum amount of effort.

The type of inclined or vertical elevators that should be adopted is dependent entirely upon the special conditions involved in each individual case, and in some cases it may be advantageous to use both types. Both systems are now in use in some of our modern freight and steamship terminals, to the entire satisfaction of the companies using them.

With reference to the question of the capacity of these types of apparatus, it is the opinion of those who have made a careful study of the subject that it is not the capacity in tonnage they are capable of handling that is the dominating factor in determining the number of machines to be installed, but the judicious placing of these machines as a matter of convenience in handling and in reducing the horizontal trucking distance.

The economic pressure now forced upon our transportation systems by the increasing cost and scarcity of labor and the congestion at terminals makes it imperative that all operating heads shall through unity of effort and investigation soon determine the most suitable methods of mechanical freight handling. The decision of three of the most important systems, that the plan outlined is the most flexible and economical, may be an indication that this method will be adopted as a uniform practice.

Growth of the Shipping Board Emergency Fleet Corporation.—Within six months of its formation the United States Shipping Board Emergency Fleet Corporation has developed an organization of more than 1,000 employees, including a large force of technical experts, many of whom have left remunerative occupations to assist in the work. The corporation has sixteen offices in various parts of the country. It is supervising the construction of 1,118 vessels in 116 shipyards distributed throughout the United States. It is disbursing for the construction of these ships something within excess of a billion dollars a year. It is controlling substantially all the shipbuilding in the country other than all naval vessels, and its programme calls for the completion in 1918 of eight times the tonnage delivered in 1916.

Fig. 1.—Hunt Storage Battery Truck Towing an Empty Freight Car Along the Quay

Freight Handling at the Panama Canal

Old System Using Freight Cars and Hand Trucks Discarded —Problem Solved by Introduction of Storage Battery Trucks

THAT the United States Government did not await the pressure of war needs to develop a high grade of efficiency in some branches of its services is evident from what has been accomplished by Mr. C. H. Mann as receiving and forwarding agent for the Panama Railroad, a branch of the Panama Canal, to whom is assigned the duty of receiving and forwarding the several hundred thousand tons of cargo transshipped each month at the Port of Cristobal, Canal Zone. In keeping with the up-to-date quay construction at Cristobal, methods of cargo handling have been so improved that the old question of how to take care of "general cargo" is no longer a serious one for the stevedore. A ship discharging heavy machinery from one hatch, structural steel from another, while tons of small cases, barrels or bagged shipments came over the side from others, offered a problem in transportation that inventive genius failed to solve, until the storage battery truck gave the answer. And the receiving and forwarding agent at Cristobal has given a demonstration.

Old System of Freight Handling Inefficient and Costly

The old system made use of freight cars and hand trucks that carried the shipments arriving from European, Atlantic or West Coast ports to various points on the one and a quarter miles of docking space, thus making it available for reshipment on other bottoms to points of destination. The ancient hand trucking process was made unusually slow because of the very deliberate movement of columns of West Indian negro, Asiatic or native truckers, who moved just as fast as the slowest man in the parade and was subject to any delay this slow man could invent. The depressed railroad tracks in each of the piers could accommodate thirty freight cars, and the delays necessary to "spot" them for loading or unloading affected the entire force on either pier. And since it was not unusual to find more than three thousand men working as ships' gangs, distributed aboard the ship, trucking or loading cars, it is obvious that the work of a large number of laborers was affected or brought to a standstill by switching. Even if this shifting was delayed until idle periods, it was necessary to truck long distances to reach certain cars. The preparation of suitable runways required much labor. Also there were many instances of damage to cargo resulting in the repeated handling.

Another large expenditure of energy came from handling heavy cases. It was not unusual to find as many as forty crated automobiles, routed for various destinations, on the piers at one time. These had to be loaded on cars in some instances, in order to convey them to the vicinity of the berth of some ship that was to carry them forward. If often happened that cars loaded with heavy cases of this sort would have to be stored for weeks before they could be unloaded. The only alternative was to use a large number of laborers to haul them over dock floors on a dolly or similar truck.

In the summer of 1915 storage battery trucks were first introduced, and with their introduction a complete revolution of method of handling cargo began. Loaded slings were lowered from the ship to the platform of the truck and rapidly conveyed to some ship then loading, probably a half mile away, and lifted aboard in the sling that had lowered the cargo. Or if not for immediate shipment,

Fig. 2.—Hunt Truck Hauling Crated Automobile on Hand Truck

the bags or cases were stacked on the truck platform, thus permitting the heavier loads, and taken to the point that would be found convenient for future loading and there stacked. Even that part of the cargo that could be best handled aboard freight cars was much more rapidly transferred by running the trucks into cars. Hand trucking was dispensed with except for very short hauls, not only reducing labor costs immensely, but reducing the time of a ship in port to receive cargo to much less than that formerly found necessary.

Railway switching and the use of cars for storage have been so reduced that it is now a comparatively small item of cost and is no longer a source of delay in the work of ships' gangs. An estimate made by the receiving and forwarding agent was that the electric trucks have reduced the charge formerly made for crews and trains $1,700 (£350) a month.

One most important saving was in the handling of heavy cases. A crated automobile is now lowered over the ship's side and set on two hand trucks, one near the center and the other forward. One of the 2-ton Hunt trucks is attached to this by a short rope and is started with no one but the operator and one laborer to assist, and rapidly taken to its proper place for reloading at any point on the docks. Heavy cases of machinery, often approximating 6 to 12 tons, are handled in the same manner except that a special "dolly" is used instead of the hand truck, and a second or third electric truck is used, either in tandem or with one running in the reverse back of the case and pushing it.

Trucks Haul Railway Cars

There seems to be nothing that the trucks will not convey and do it rapidly and with the use of very little labor. It may be said in this connection that considerable shifting of railroad cars is effected in the same way. Two Hunt trucks will readily move a loaded freight car, gaining approximate speed in ten or fifteen seconds. One truck easily moves an empty car.

One use that has been made of the truck, but which is now tabooed, is in the shifting of barges. Sufficient tractive effort is available, but it is impossible to attain the truck's rated speed or control the barge so set in motion. This is mentioned only to show the sincerity of the stevedore's faith in the truck which efficient service has engendered in the minds of the men who use them. Tractive effort to them is simply "power to pull," so anything that needs to be pulled or pushed may properly claim the service of a truck.

Lifting heavy loads by block and tackle is a regular service. The hoisting of the heavy ore nets, which weigh about 1,000 pounds, to their storage platform or the place from which they are often suspended, is now a regular duty of the truck. In accomplishing this they have replaced no less than a half-dozen laborers and do more rapid work. When hoisted, the truck brake holds them until tied or landed on the platform. Properly geared, they will hoist anything within their capacity and they have often been used in lifting a load of more than a ton.

Truck operators on the Isthmus are nearly all West Indian negroes. A few are Chinese boys. All develop skill after a little experience that makes of them excellent operators. Of course, the personal element enters into it, developing some as careless, but the supply is abundant, so there is no difficulty in getting them. Harmful methods of handling trucks are more often due to improper demands by dock foremen, who have expected one truck to do the work of two or three. In spite of occasional mishaps, the service is excellent. As evidence, it may be truthfully said that the fifty-two Hunt trucks on the Isthmus, some of them now well along in their third year of a continuous, day and night service, are *all doing just as much work* as they did when they were new.

It may be well to explain that the Hunt trucks on the Cristobal piers are so operated that three-fourths of them are at work all of the time, both day and night. They come in in relays to have batteries charged, and by the aid of time gained during the idle dock periods between 5 A. M. and 7 A. M. and between 5 P. M. and 7 P. M.,

Fig. 3.—Hunt Truck Operating With Tackle Hoisting Freight to Second Floor of Terminal Shed

there is sufficient opportunity to keep the batteries in excellent condition.

Cost of Operation

The cost of operation is an easy calculation. Pay of operators plus the cost of charging, maintenance and minor repairs, amounts to about $2 (8/4) per day for each truck. But it must be borne in mind that a truck gives fifteen hours' actual service for that $2 (8/4) a day. At least 85 percent of this charge is for labor, while the actual cost of power or the current for recharging of batteries is not more than 8 percent or about 16 cents (0/8) per day. (Less than 1 cent (0/½) per kilowatt hour is the Isthmian rate.)

Probably water power alone can deliver equal energy at a like cost.

There is no attempt in this to estimate depreciation of equipment or include interest on investment. It may be said, however, that depreciation is less than is the rule for other types of commercial vehicle, and the electric vehicle of the industrial truck type seems almost indestructible. Witness the fact that those in Panama have made leaps off pier runways to concrete floors ten feet below, into railway track pits, even diving into the sea to a depth so great that it required the services of a diver to find it. They have collided with each other, with concrete walls and columns—have even been struck by a locomotive. Yet in no case have they been out of service long and all go about their work as if nothing had come into their lives but benevolent care.

Definite figures as to saving effected by the use of trucks in handling cargo on the Panama Canal piers are difficult to obtain and probably have never been clearly ascertained. But the general fact is known that the monthly cost of stevedoring has been reduced many thousands of dollars during the past two years. It has been unofficially stated that this has amounted to $30,000 (£6,150) a month, and such an amount does not seem improbable, for it would represent economics effected by the substitution of many efficient methods in the handling of ships' cargoes.

The largest single item of efficiency, however, would be found in the speed with which the work is done and labor cost curtailed in the service by the storage battery industrial truck.

Shipbuilding Department Formed in Bridgeport Trade School

The State Trade Education Shop of Bridgeport, Conn., which is conducted under the direction of the State Board of education and is in charge of James F. Johnson, director, has established a shipbuilding department which gives both day and evening courses in practical shipbuilding. This new department is co-operating almost entirely with the needs of the Lake Torpedo Boat Company in their problem of submarine construction. The teachers are men who have had practical experience at the trade and are able to give first-hand instruction in the details of the work.

The day work is confined entirely to the training of apprentices for the Lake Torpedo Boat Company. Young men enrolled in these classes work one week in the shipyard and the following week are under instruction at the trade school. They receive pay at the same rate while under instruction as while at work in the shops. The evening school instruction, for which over 160 men have enrolled, is for employees at present engaged in the various shipbuilding branches who wish to acquire further knowledge of the work.

The school has acquired 2,000 square feet of floor space in a new office building, which is used as a mold loft in which the actual work is laid down. Thorough study is given to the branches relating to ship fitting.

S. S. Fairmont

The S. S. *Fairmont,* the first of a contract for five sister ships, placed with the New York Shipbuilding Corporation, Camden, N. J., by the Coastwise Transportation Company, Boston, Mass., about a year ago, was launched on December 8, about 90 percent complete. Although built to the order of the Coastwise Transportation Company, the vessel has now been taken over by the United States Shipping Board Emergency Fleet Corporation.

The vessel is a steel single screw collier of the single deck type with poop, bridge and forecastle with machinery amidships designed for coastwise and overseas trade. She is 395 feet 4 inches long overall, 377 feet 4 inches long between perpendiculars, 55 feet beam molded and 24 feet 5 inches depth molded. There is a double bottom all fore-and-aft, divided into seven compartments for water ballast or fuel oil, the forward and after peaks being for ballast. The total capacity for water ballast in the double bottom and peak tanks is about 1,900 tons.

The capacity of the cargo holds, including the trunks, measured to the top of the tank, is 337,500 cubic feet. The coal bunkers have a capacity of 1,350 tons at 43 cubic feet. The vessel is to carry 8,600 tons total deadweight on the British Board of Trade freeboard, summer draft, and in this trim will make 10½ knots sea speed under ordinary conditions.

Eight cargo hatch openings, each 15 feet 9 inches by 28 feet, are provided to facilitate the rapid handling of a cargo of coal. The hatch coamings are strongly built, forming a solid girder along each side, being suitably braced and secured to the deck so as to carry the deck between the webs and enable pillars to be dispensed with in the main holds. Each hatch has a single cover made of steel plate.

The vessel is schooner rigged with two steel cargo masts fitted with tubular steel booms, each capable of handling a 5-ton working load except one boom on the foremast, which is designed for a 12-ton working load. Instead of stepping the masts on the tank deck, they are heeled on a strongly built platform on the bulkhead 5 feet below the deck. King posts are fitted for handling the hatch covers, one pair for two hatches.

Propulsion is by a triple expansion surface condensing reciprocating engine with cylinders 25, 41½ and 70 inches diameter with a common stroke of 46 inches supplied with steam at 195 pounds working pressure by three single-ended Scotch boilers, 13 feet 10 inches mean diameter and 10 feet 6 inches long between heads arranged for either coal or fuel oil burning. The main condenser is independent of the engine and contains about 3,300 square feet of tube cooling surface. An auxiliary condenser of 800 square feet tube cooling surface is also installed to take care of all auxiliary machinery. The vessel has a complete equipment of fire, bilge and sanitary pumps, ice machine and electric light plant.

The United States Shipping Board has allotted $3,500,000 for building twenty-four barges and four towboats to be utilized in river traffic between St. Louis and St. Paul.

Development of Machinery in the United States Navy During the Past Ten Years*

Magazine Refrigeration—Cruising Economy of Destroyers—Performance of Reciprocating Engines—Mechanical Reduction Gears—Electrical Propulsion

BY REAR-ADMIRAL C. W. DYSON, U. S. NAVY

The dreadnaughts up to this time authorized or building were of the five-turret type with the magazines for one turret located between the engine and firerooms. In order to reduce the naturally high temperature of this magazine some system of artificial cooling was necessary.

Two systems have been tried out, one with closed air circulation and the other with the cooling medium circulating through pipe coils in the magazines.

Magazine Refrigeration

Difficulty was experienced with the first system when first applied, due to the moisture in the air frosting up the air coolers through which the refrigerated air from the machines circulated. These cooler pipes would become heavily coated with frost, which is a most excellent non-conductor, and when so coated no further degree of cooling of the magazine air was possible. The persons operating the machines did not appreciate this fact, so, as the frost gathered, the machines were driven harder and harder until something would break.

Reports were immediately made laying all the troubles to "defects in design," when really the trouble was due entirely to operation. This criticism of "defects in design" is met with constantly whenever any troubles are experienced. The personnel are always held blameless, and quite naturally, as those operating the machinery are doing so to the best of their ability and are loath to admit that the fault might possibly rest with them.

Following these ships, appropriation was made for the *Arkansas* and *Wyoming* and for eight destroyers. The plans prepared for the two battleships were practically duplications of those for the two preceding vessels.

Proposed Combination Machinery

The Department did, however, invite bids on a layout of combination machinery developed by it. This differed from the ordinary type of combination machinery that had been used in the merchant marine. In this latter machinery the reciprocating engines and the turbine combined with them each developed about the same power, the steam pressure at the turbine inlet being that which is usually met with at the exhaust of a triple expansion engine, about 12 pounds absolute. With the ordinary merchant vessel the ranges of speed and power used in actual service are very limited, and the machinery can be designed for maximum efficiency within these ranges. With vessels of war of high or moderately high speeds the range between ordinary cruising speed and power and full speed and power is extensive, and the combination machinery must be so designed that the turbine will deliver power down to and, if possible, slightly below the cruising speed in order that it may not cause a drag and an absolute loss in efficiency. To accomplish this it is necessary to design the reciprocating engines as compounds, but having the same ratio between the high and low pressure cylinders as exists in the ordinary triple expansion engine. The function of the low pressure cylinder is then performed by the highly efficient low pressure turbine. The initial pressure at the turbine at full power in such a case should be about 30 pounds absolute. The whole scheme really can be considered as one in which the comparatively inefficient H.P. turbine and L.P. cylinder are replaced by the much more efficient H.P. and I.P. cylinders and L.P. turbine.

Bids were received for such an installation, but it was decided not to go into the experiment at that time. About two or three years later, the French Government did install a similar arrangement in several new battleships. With this same year, 1909, the subject of electric propulsion first made its appearance on the naval stage. Mr. W. L. R. Emmet approached the Navy Department with proposals to fit electric propelling machinery on one of the new vessels, but the Bureau of Steam Engineering advised against it, considering that the new problem should be at least partially solved by installing and trying out an installation on a less important vessel before committing itself to its installation on a capital ship. The opportunity to do this did not offer until two years later.

The destroyers of this program were all of the two-shaft design, four of them having improved Zoelly turbines, two Curtis turbines and two Parsons turbines, the latter having a H.P. turbine on one shaft, a low pressure on the other, and having only a single condenser, which constitutes a very weak point in these vessels.

Destroyers

These destroyers are the starting point for high cruising economy in destroyers, the General Board of the Navy having required that they should have a certain specified cruising radius at 15 knots speed.

This requirement necessitated other than ordinary cruising turbines to realize the necessary economy, and therefore, as the speed of rotation at 15 knots was comparatively low, small compound reciprocating engines working in combination with the turbines were fitted, connected to the main shafting by disconnecting couplings. These engines were disconnected for speeds above 16 knots. The combination was an unqualified success so far as the resultant economy was concerned, a reduction in fuel of from 25 to 50 percent below that required for the main turbines only was realized, 49 percent at 10 knots, 37 percent at 13 knots and 25 percent at 16 knots, results well worth the expense and slight complication involved.

Some of these engines were made reversing, but the majority were made non-reversing, which was the form preferred by the Department. Barring some slight troubles, everything worked well with the exception of a form of friction clutch which had been fitted on four of the vessels.

The history of this clutch is a very good example of the difficulties the inventor encounters in the development of a new idea before success is finally realized, and, being such, I will detail this history to you.

* Reprint from the Journal of the Society of Naval Engineers, continued from December, 1917, issue.

The clutch was oil-controlled of the single friction-disk type, and was designed by Mr. John F. Metten, Chief Engineer of the Cramps' Shipbuilding Company, in an honest and finally successful endeavor to meet the Department's specifications. These called for the small cruising engines to be coupled to the main shafts by couplings which could be connected and disconnected with the machinery in motion.

Metten Friction Clutch

The clutch, as already stated, was of the friction type. The single friction disk of plate steel was thickened into a boss at the center and bolts passed through this boss and a boss in the end of a short length of intermediate shafting fitted between the after end of the engine shaft and the forward end of the main shaft. The after end of this intermediate shaft was forged out into a Tee end, which was held up to and worked in a slot across the end of a disk on the main shaft, thus providing a flexible coupling to care for changes in alinement.

When the couplings were put into service the first troubles were experienced with the coupling disk, which would heat up under load and warp. To obviate this trouble the edge of the disk was divided into segments by slitting it, the slits cutting in radially for about four inches. The remedy was effective.

The next weak point to develop was the bolting of the disk to the shaft. These bolts were then made much heavier. The shafts then began to break at the point where the form changed from cylindrical to the Tee. This form of flexible coupling was then abandoned and a flexible coupling with entire circumferential engagement was fitted. Everything but the cylindrical portion of the shaft having had its inning and been corrected, the body of the shaft began breaking up badly and some of the shafts broke. The trouble was analyzed as due to torsional vibration and the shafts were at once discarded and replaced with new ones of heavier weight and larger diameter. Since all of these changes were made the clutches in all their parts have been satisfactory.

This year's appropriation also called for one collier. This vessel, the *Cyclops,* was fitted with reciprocating engines of the straight-port type, and, when finished and tried out, gave a very creditable performance. She is mentioned here because a sister ship was laid down the next year fitted with mechanical reduction gear, and the year following a similar vessel fitted with electric propulsion. These new forms will now be taken up.

Mechanical Reduction Gear

For several years anterior to the date of which I am speaking, Sir Charles Parsons, in England, and Rear Admiral George W. Melville, coöperating with Mr. John H. MacAlpine, under the patronage of Mr. George Westinghouse, had been investigating the possibilities of mechanical gearing for interposition between turbines and propeller shafting in order to combine the high efficiency of the steam turbine with the high efficiency of slow-turning propellers. This was not the first appearance of such gearing, however, as it had been used in a few instances years before, but for a quite different purpose. The earlier reciprocating engines were very heavy, of long stroke, and very slow moving, and the gearing in these cases was interposed to bring the revolutions of the propellers up.

Sir Charles Parsons already had an installation in successful operation on the merchant ship *Vespasian.* Mr. Westinghouse had built a unit and had carried out a very successful shop test, but as yet had made no marine installation. The Maryland Steel Company, which received the contract for the *Neptune,* the sister ship of the *Cyclops,* proposed to the Navy Department that the main propelling machinery be changed to turbines and reduction gear and the Bureau of Steam Engineering recommended approval of the proposition.

As the installation was experimental, the contract was so drawn that in case of failure the turbines and reduction gear would be replaced by reciprocating engines similar to those of the *Cyclops,* and in order to allow of this the shaft lines and dimensions were so fixed as to allow the one type of machinery to be removed and the other installed without change of line shafting.

The Westinghouse gear as originally designed had the pinion bearings carried on an I-beam, which provided a certain amount of flexibility for the pinion shaft and was supposed to take care of any small disalinement which might occur between pinion and gear wheel. Before the gears were built, however, this I-beam was replaced by two hydraulic cylinders to which the oil was pumped by the bearings and which by the oil pressure shown gave an accurate gage of the power being exerted.

Westinghouse Gear

Mr. Westinghouse, being before everything else an inventor, saw here his opportunity and allowed his inventive genius to run riot. He designed a new type of marine turbine, the first stage being an impulse one, the remainder being of the reaction type. The big difference between this turbine and the ordinary Parsons turbine was in the location of the backing turbine. This was in the same casing with the ahead turbine, but was directly forward of the H.P. end of that turbine, being steam-sealed from it by a dummy fitted with labyrinth packing. The backing turbine exhausted through the rotor drums to the regular exhaust outlet. This turbine was a failure from the beginning, as there was continual loss due to steam leakage from the ahead to the backing side, causing both loss in steam and in power. He designed a bridge control on the air brake principle by which the main engines could be operated from the ship's bridge. This never won favor, and but recently a request has been received from the vessel to remove it. He installed Westinghouse-LeBlanc water-sealed rotary air pumps. These used salt water as the sealing medium and discharged it overboard. The loss of fresh water due to the vapor which became entrained with this salt water and was then discharged overboard was enormous. Everything about the installation which had been installed by the Westinghouse Company was a failure with the exception of the reduction gears, which were unqualifiably successful.

Later the turbines were removed and replaced with others of the same type but greatly improved design; the air pumps were replaced with others using fresh water on a closed circuit as a sealing medium; and in order to improve the efficiency of propulsion, the gears were changed in order to reduce the propeller revolutions from 132 to 110 at full power. The new installation is now on the vessel, and, after passing through a few vicissitudes, is operating satisfactorily.

Electric Propelling Machinery

Let us now turn to a more pleasing picture. I refer to the installation of electric propelling machinery on the collier *Jupiter.* This installation was undertaken by the General Electric Company the year following the beginning of work on the *Neptune.*

This being also an experimental installation, the Navy Department guarded itself from loss exactly in the same

manner as had been done on the *Neptune*. This necessitated the installation of only one main turbine and generator in order that the shaft lines might not be disturbed.

The generator turbine was of the G. E. Curtis type. The generator is totally enclosed and the rotor has fans on each end which take air in at the bottom of the casing and blow it out through the windings, passing thence through a discharge duct on top of the generator casing. The exciting current for the revolving field is supplied to slip rings on the generator shaft by one of the ship's lighting sets.

The motors, one on each shaft, are of the induction type, with a stator 120 inches in diameter and a rotor 110 inches. They are located in watertight pits which cannot be filled by water from below. Being situated directly under the engine-room hatches, they are liable to be deluged with water from above, and the insulation of the windings is therefore made waterproof and are intended to give safe running when partially submerged.

The first turbine constructed for this job was not entirely satisfactory to the General Electric Company and they voluntarily scrapped it and constructed a new turbine having very greatly improved blading. The results obtained with the new turbine showed much improvement and the completed units were installed. Barring the coming adrift of an internal turbine bolt, the installation has been perfectly satisfactory since first tried out. It has been subjected to water, insulation has been injured so that a spark jumped from one end of the armature to the other, the ship has gone through exceptionally heavy weather, and the installation is as satisfactory to-day as when first installed.

Reciprocating Engines for the Texas and New York

The next vessels to be contracted for—that is, battleships—were the *Texas* and *New York*, and the Navy Department was accused of having taken a step backward when it was decided to put reciprocating engines in these vessels. The reasons for this step will now be given. A careful study of the performance of the *North Dakota* and a better understanding of the factors governing propeller performance had assured the Bureau that no great economy of propulsion could be expected so long as the turbine builders adhered to what was at that time current turbine practice. That is, as pointed out before, they were sacrificing propeller efficiency deliberately in order to obtain a high turbine efficiency and so be able to hold down weight and space to the lowest possible limit. The Bureau, by its action, was attempting to force them into a change by which the greatest combined efficiency of turbine and propeller could be obtained, and, as later developments indicated, these efforts finally met with success.

In furtherance of this idea, while the plans as prepared showed an installation of Parsons turbines, the Bureau unofficially informed some of the prospective bidders that a proposal to fit reciprocating engines would be given serious consideration.

When the bids were opened the Newport News Company was found to have submitted such a proposal and the Bureau of Steam Engineering promptly recommended acceptance. This action of the Bureau had not yet become public when parties interested in the Curtis turbine invaded Washington and began a vigorous campaign for that turbine, at first urging the installation of turbines similar to those they were then installing on the Argentine battleships *Rivadavia* and *Moreno*, turbines which had to be nearly completely rebladed with a heavier type of blade than originally installed before they could even get through their preliminary acceptance trials. When they did finally pass these trials the water consumption trials at all speeds were far in excess of the guarantees. Later in the campaign the advocates of the Curtis turbine proposed the installation of compounded turbines—that is, a high and a low pressure turbine on each shaft, the installation to be a two-shaft one. The fight was taken up by the Bureau and was carried to the General Board, which was made the judge in the case by the Navy Department. No guarantees were too severe for the turbine people to meet, on paper, so long as they could equalize the estimated performance of the reciprocating engines. Fortunately, the Bureau was the victor, and reciprocating engines were installed in the two vessels now known as the *Texas* and *New York*, and the Navy Department has never had occasion to regret this action. It is pertinent here to call attention to the fact that some of the parties engaged in this controversy on the turbine side are now even more actively engaged in a newspaper campaign to force turbine-driven reduction gear into the battle cruisers which we are just starting to build, and in this case every bit of evidence they have to support their contentions as to the superiority of the installation they are advocating over that of the electric drive is hearsay of the most meager description.

As stated before, the Department has never had occasion to regret its decision in regard to the type of machinery installation for the *Texas* and *New York*, for from the coal consumption reports received from the fleet, it costs no more to drive the *New York* at 12 knots than it does to drive the *Delaware*, and 17 percent less than the *Florida* and *Utah*, and 27 percent less than the *Arkansas* and *Wyoming*, even with the much heavier displacement of the *New York* than that of the three vessels first named and the slightly less displacement of the *Arkansas* and *Wyoming*.

Turning again to the destroyers, the next step forward in the design of their machinery consisted in the adoption of turbines and reduction gear for cruising units, these replacing the small reciprocating engines which had been fitted in the preceding classes. This change was brought about by the General Board, which raised the speed for the guaranteed cruising radius from 15 up to 20 knots. As this latter speed required too high revolutions for a reliable reciprocating engine, it became necessary to look for something that was reliable to replace it. Turbines with reduction gears was the answer.

To carry the destroyers up to date and clear them off the board, I will carry them through their remaining history at once. The next and only change which has occurred with their machinery since the adoption of reduction gear for cruising has been to pass from the direct-connected turbine main drive and adopt turbines and reduction gear for this purpose. This action led to the abandonment of special cruising elements for destroyers, as quite a good (and nearly as good as with the cruising elements) economy at cruising speeds could be obtained with the main turbines, while the economy at high speeds was enormously increased. The weights of the six types of destroyer machinery, based on designed power, are as follows:

	Main Propelling	Cruising Element	Total Weight, Pounds Per Designed S.H.P.
(1)	Parsons turbines	Cruising turbines	51
(2)	Curtis turbines	Cruising nozzles	56
(3)	Parsons turbines	Cruising engines	47.5
(5)	Curtis turbines	Cruising engines	48
(6)	Parsons turbines	Reduction engines	46
(7)	Curtis turbines	Reduction engines	46.5
(9)	Geared turbines		42

(To be continued.)

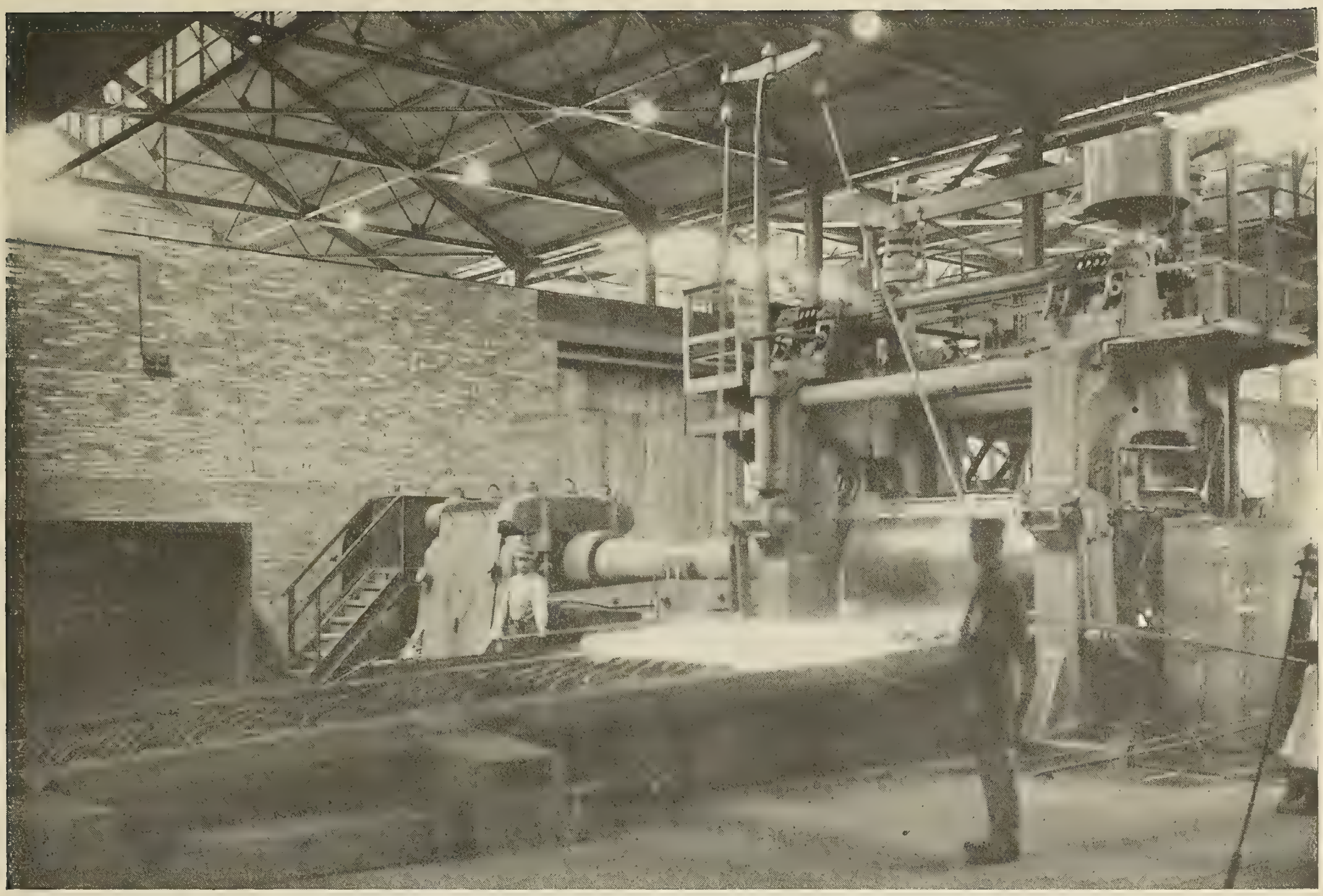


Fig. 1.—Front View of 110-Inch Liberty Plate Mill Rolling Ship Plates, October, 1917

The Liberty Mill

110-Inch Plate Mill Built in Record Time by Carnegie Steel Company for Rolling Ship Plates for Emergency Fleet

THE construction of the 110-inch Liberty Plate Mill by the Homestead Steel Works of the Carnegie Steel Company in six months is an engineering achievement which justly deserves mention, even at this present time of rapid construction of buildings for emergency uses.

The Liberty Mill is an emergency mill built in the first instance to roll ship plates for vessels under construction for the Emergency Fleet Corporation, but it has been built in the most substantial way to serve the nation when the war is done. A mill of this size had not been under consideration at Homestead Steel Works when the order to build the mill was received. There were no spare parts which could be taken from other mills, no engines, no machinery available. No pencil had ever been put to paper in the way of preliminary estimates or designs.

Work Involved

The construction of the mill required the removal of 70,000 tons of scrap and miscellaneous material on the site (2,400 carloads); 71,950 cubic yards of excavation; 50,120 cubic yards of back fill; 17,147 cubic yards of concrete; the laying, changing and removal of 40 miles of temporary track; the construction of a 5-foot sewer 1,000 feet long; it required the construction of an addition to the Carrie Furnaces power house with a new 46-inch by 66-inch Snow twin tandem gas engine direct connected to a new General Electric Company 3,750 KVA generator; the building of a transmission line two miles long across the Monongahela River on two towers 115 feet high and 1,007-foot span; the building of seven mill buildings with a total area of 215,000 square feet; the manufacture, fabrication and erection of 3,390 tons of structural steel; together with the heating furnaces, rolling mill, 4,000 horsepower main motor, subsidiary motors, straightening rolls, shears, cranes, etc., necessary for the operation of the mill itself.

Labor

The mill was built by men whose hands were already full; men whose works were operated to capacity with unusual difficulties at an unprecedented time; men whose minds were occupied with the problems of insufficient coal supply, scarce and inefficient labor and transportation difficulties. Ordinary labor was practically unobtainable; in consequence steam shovels and machine tool methods were in use. Orders were received to build the mill on April 17, 1917, but it was six weeks after that date before it was possible to secure laborers.

Volunteer labor saved the day. Officials and clerks from various Homestead Steel Works offices, both general and departmental, officials and clerks from the general offices, Pittsburgh, Homestead Steel Works department heads, mechanics of all trades, skilled and semi-skilled mill workmen were represented in the forces which on Saturday afternoon, Saturday night and Sunday cleared up the stagnation which had accumulated during

the week on account of the shortage of regular laborers. At one time as many as 450 volunteer workmen were on the job.

Organization

The work was carried forward under the supervision of A. A. Corey, Jr., general superintendent, Homestead Steel Works; R. H. Watson, assistant general superintendent, and J. W. Grady, manager producing departments. Daily conferences were held at the site at 7.30 A. M., and each division of the organization had the direct oversight of that portion of the new plant which it was finally to operate, including design of machinery, its purchase, etc. F. B. Schaeffer, chief civil engineer, was responsible for the grading of the site, laying of foundations, sewers, underground work, equipment, back fill, railway tracks, etc. The design of the mill buildings and the general mechanical engineering work was in the hands of A. W. Soderberg, chief mechanical engineer. Cranes, motors and all electrical equipment came under C. A. Menk, chief electrician. Richard Moon, master mechanic, had the oversight of the mill machinery, pumps, etc. Charles S. Frye was superintendent of construction, and Kenneth Lean superintendent of transportation and labor. James Horton, efficiency engineer, acted as special ambassador to the various contracting firms building mill equipment. Each department worked out its own problems.

Site and Foundations

The 110-inch plate mill and its tracks cover an area of nine acres on the Monongahela River, west of the Howard Axle Works in West Homestead. On this site on April 17, 1917, were 70,000 tons of scrap and miscellaneous material, or 2,400 carloads. Thirty thousand tons of scrap, 2,000 tons of loam, 700 tons of black clay and odd lots of sand, gravel, chrome ore, etc., had to be moved before the first pick could be sunk, and the first pick was a 73-ton, 2½ cubic yard Marion steam shovel borrowed from the Union Railroad.

The foundations are all concrete, continuous for the brick buildings and of the single pier type for the main mill building columns. The concrete was mixed in eight Smith & Co. concrete mixers, four of them of ⅓ cubic yard capacity and the other four the small mixerette, 5 cubic-foot size.

Mill Buildings

The group of buildings comprise seven distinct units at West Homestead in addition to the power house extension at Carrie Furnaces. The slab yard building is 70 by 293 feet; the heating furnaces building, 106 by 293; the mill building, 70 by 293; the shipping building, 80 by 864; the shear building, 80 by 764. The mill superintendent's office, 46 by 64 feet, is of semi-fireproof construction and contains offices, vault, toilet and rest room.

It is customary in rolling mills to have the mill building itself contain equipment in the way of pumps, motors, accumulators, etc. In this installation all of the subsidiary machinery has been removed from the main mill building and segregated in a special mill office, comfort and power building 242 feet long by 40 feet wide, built of brick and covered with Barrett specification roofing. This building contains three 500 kilowatt transformers built by the Pittsburgh Transformer Company, two 1,500 cubic foot Bury air compressors, two 5⅝- by 12-inch Epping-Carpenter duplex pressure pumps, two water filters, return water tank, 24-inch accumulator, and in addition the physical testing laboratory, physical test bending room, physical testing machine shop, locker and wash room with 288 steel lockers, inspector's offices, janitor's room, oil room, toilet room, rest room, vault, etc., and has its own heating plant in the basement.

The separation of machinery from the mill proper has been carried a step farther so as to make the installation clean, clear and safe. The 4,000 horsepower motor which drives the mill is housed in its own separate brick building built under the main mill roof and containing in a separate room the switches, resistance coils and other accessory electrical equipment.

The steel work for the mill buildings was designed by the American Bridge Company. It was fabricated in part by the Ambridge plant of that company and in part by the Upper Union Mills Fitting Shop of the Carnegie Steel Company. The steel work for the Carrie Furnaces power house extension was detailed at Homestead Steel Works and fabricated in its own shop. The ability of the works to manufacture and fabricate its own steel and to do machine shop work was quite a factor in the rapid construction of the buildings.

Buildings and machinery were designed and ordered without any rechecking. Drawings came out of the drafting room daily, and the most remarkable feature of the engineering work was that there were absolutely no mistakes. Not one piece went out of the shops that had to come back.

The mill buildings were erected by the American Bridge Company with its own force. Work was begun on Thursday, August 2, and finished on September 22 in the record time of forty-nine days.

Power

This mill is the first electrically driven plate mill to be operated by the Carnegie Steel Company. It is entirely electrically driven from start to finish. The main motor is a 4,000 horsepower General Electric motor. The crane motors, table motors, shear motors, motors for driving pumps, etc., were built by the Westinghouse Electric & Manufacturing Company.

The power furnished is alternating current, 3-phase, 25-cycle, 6,600-volt, developed at a central power station at Carrie Furnaces by a 46-inch bore by 66-inch stroke Snow twin tandem gas engine directly connected to a General Electric 3,750 KVA generator. Power is transmitted to the mill on overhead lines carried on poles. This line spans the Monongahela River on two towers 115 feet high having 30-foot bases. The main mill motor takes current at the original voltage. At the subsidiary motors the voltage is reduced to 220.

Rolling Mill Machinery

The mill itself is a three-high plate mill with 110-inch length of roll body. Top and bottom rolls are 36 inches in diameter, middle roll 21 inches. The rolls are chilled iron and were made by the United Engineering & Foundry Company, of Pittsburgh.

The mill was designed by Homestead Steel Works and built jointly by Mackintosh, Hemphill & Co. and the Mesta Machine Company, Pittsburgh. Mackintosh-Hemphill made the mill, large castings for charging machines and cranes, including mill housing. Machining was done by Homestead Steel Works. Mesta Machine Company made the pinions, the pinion housing, the pinion shoes and the mill shoes. The practice on motor-driven mills has been to use machine-cut pinions. It was impracticable to have these cut and so they were made machine molded and operate as noiselessly as any cut gears.

The mill is served by seven cranes and two overhead traveling charging machines, namely:

One 15-ton crane in slab yard.

One 50-ton crane in mill building.

Fig. 2.—Straightening Rolls and Cooling Tables

Three 10-ton double trolley cranes in shipping building.

Two 10-ton single trolley cranes in shear building.

Two 10-ton overhead traveling charging machines in heating furnaces building.

All these cranes and their equipment were made by Homestead Steel Works itself. There are three main shears, two side shears with 144-inch knife, and an end shear with 110-inch blade, all made by the Morgan Engineering Company, Alliance, Ohio. The two scrap shears were made by the Cleveland Punch & Shear Works. The straightening rolls were made by R. S. Newbold & Son Company, Norristown, Pa., and consist of a machine with nine rolls 14 inches in diameter and 116 inches long. The roll tables were made by Homestead Steel Works in their own shops.

The heating furnaces building houses eight regenerative heating furnaces. At present furnaces are heated with natural gas. They may be heated with either natural gas, oil or tar. Ultimately, when the full schedule of improve-

(*Concluded on page 42.*)

Fig. 3.—Charging Machines and Reheating Furnaces

Duties of Newly Trained Marine Engineers on Merchant Vessels—III

Notes on Feed Water—Testing Water for Corrosiveness—Construction and Operation of Evaporators—Principal Systems of Forced Draft

BY C. H. WILLEY

BOILER feed water should be as free from impurities as possible. Some of the most serious met with are oil, grease, air and salts of sea water. To prevent these from entering into the boiler will require considerable effort and attention of the engineer. On board ship the sea water is evaporated and distilled to obtain that needed for make-up feed when the feed tank capacity is used up. The distilled water is apt to be corrosive, so it will be seen that it is important that the amount of make-up feed should be kept to a minimum.

Scrap iron is sometimes suspended in the hot well or feed tanks to absorb the oxygen. If a feed heater is used, there is generally fitted a ½-inch pipe leading from the hottest part of the water space to the hot well or feed tanks. The valve fitted on this vent line should always be kept cracked off its seat to allow part of the water and any accumulated air to escape.

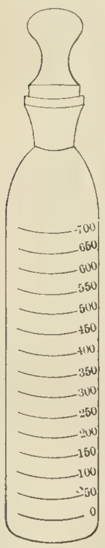


Fig. 1

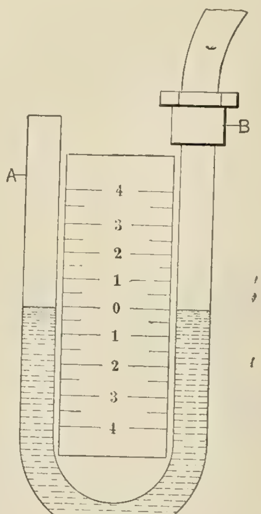


Fig. 2

In order to remove as much oil and grease as possible from the water before it enters the boiler, some ships are fitted with feed water filters. The number of devices for this purpose are large, but nearly always a filter tank is used, consisting of several compartments at the top, each connecting to the other through perforated plates. In these chambers are placed the filtering material, which usually is some fibrous material, such as loofa sponges, excelsior, bagging, etc. These materials collect the oil, grease and impurities. When they become badly fouled, they can be removed and washed or renewed. Generally the discharge of the air pump leads into these filter tanks, and they drain to the feed tank.

Grease extractors are sometimes fitted to the feed lines. These consist of a vessel that forms a part of the line, this being fitted with a bypass around it. In this vessel is fitted a perforated cartridge or cylinder, over which is wound and sewed Turkish toweling covering; this takes up such grease and oil, etc., that gets by the filter tanks.

The salinity test of the boiler feed water will indicate whether or not any considerable amount of solids are being introduced into the boiler. To ascertain the amount of grains per gallon in the water used the B. & W. test has proven most popular with many engineers.

A graduated bottle or test tube designed to be used with chromate indicator and silver nitrate solution is used in making the test. The bottle of silver solution is made up of 4.738 grams of silver nitrate to 1,000 grams of pure distilled water. The chromate indicator is a 10 percent solution of pure potassium chromate.

Testing Water for Corrosiveness

The test is made as described in "Marine Steam," by filling the graduated bottle, Fig. 1, to the zero mark with the water to be tested. Add one drop of the chromate indicator, then slowly add the silver solution; keep shaking the bottle. On nearing the full amount of silver solution required, the water will turn red for a moment and then back to yellow again when shaken. The moment it turns red and *remains red,* stop adding the silver. The reading on the graduated bottle at the level of the liquid will show the amount of chlorine in grains per gallon. For example, if a permanent red color is shown when the level is midway between 150 and 200, there are 175 grains of chlorine per gallon.

The principle of the process depends upon the fact that if some of this silver solution be dropped into water containing a chloride, a curdy white precipitate of chloride of silver will be formed. If there is also present in the water enough potassium chromate to give a yellow color, the white precipitate will continue to form as before, owing to the silver having a greater affinity for chlorine than for the chromic acid in the chromate. But, at the moment when all the chlorine in the sample has been converted, the silver will attack the yellow potassium chromate, and chromate of silver will be formed, which is red in color. The amount of chlorine present is, therefore, shown by the amount of silver solution required to convert it all to silver chloride, and the determination of the exact point at which the chloride precipitate ceases to form is greatly facilitated by observing when the chromate indicator turns from yellow to red.

It is not necessary to add the silver solution until the color becomes very red, as the delicacy of the reaction would be destroyed, but the change from yellow to yellowish red must be distinct and must not change on shaking. The sample of water to be tested should be neutral, as free acids dissolve the silver chromate. If it should be acid, neutralize by adding sodium carbonate. Slight alkalinity does not interfere with the reaction, but should the sample be very alkaline it may be neutralized with nitric acid.

Should it happen that the color does not change within the limits of the graduations, the sample may be tested by diluting with distilled water. For example, add three

parts of distilled water to one part of the sample. If, then, on testing the mixture, the color changes at 200, the number of grains per gallon in the original sample will be four times this reading, or 800 grains.

The chlorine should be kept down to the least possible amount—say below 50 grains per gallon—as the nearer the boiler water is to fresh water, the safer the boilers are against corrosion.

As a general rule, when sea water is being unavoidably allowed to enter the feed water used for the boilers, blowing down should not be resorted to until the saturation test shows an excess of 600 grains of chlorine per gallon in firetube or B. & W. boilers, 300 grains in Niclausse boilers, and 150 grains in small bent-tube or torpedo boat boilers.

If the water is so corrosive as to be acid, blue litmus paper, which has not been allowed to deteriorate through exposure to the atmosphere (keep in a bottle with a glass stopper), will turn slightly red. If a change in color is not apparent at once, it should be allowed to remain in the solution a few minutes and then carefully dried and compared with an unused sample.

Another method is to put into it a few drops of a chemical called methyl-orange. This methyl-orange gives a yellow color so long as the water is alkaline, but if turned pink it shows that the water is acid and therefore highly corrosive. The latter test is more sensitive than the litmus paper test, and should be used in preference.

Evaporators

The working of an evaporator is practically the same as a boiler. The water in an evaporator is heated by steam coils, whereas in a boiler it is done with hot gases. There are several types in use, but all are designed on the same principle. The latest type is that of the Reilly multicoil; in this the heating is done by a series of coils, each one of which is detachable by breaking a union joint at each end. The big feature of this is their accessibility for cleaning of scale to make repairs.

The operation of a single evaporator is as follows: The shell is filled to the top of the coil. The vapor valve on top of the shell is closed, and then steam is turned into the heating coil, the drain of which is opened to the trap. While the pressure of the shell is building up, the distillers are made ready by starting the distiller circulating pump and opening the condensate discharge valves to the distilled water measuring and testing tanks.

When the steam pressure has built up to 10 pounds, the vapor valve is carefully cracked open. The main thing about pressure of the coil and shell is to so regulate the two that no priming or foaming will result, and yet obtain capacity. This varies according to the length of time the coil has steamed without cleaning the salt scale. In practice, 40 to 50 pounds gage pressure on the coil will give 10 to 15 pounds on the shell.

To prevent priming, general experience points out that the water of the shell should be carried below the first two rows of tubes or coils, so that the bubbling water will come in contact with these exposed tubes and flash into steam. It must be kept in mind that salt water tends to foam more violently than fresh water. In feeding, the feed stop should be regulated to keep the water level constant. A string tied on or some mark made at the correct height on the gage glass helps to keep it so. Owing to its high evaporative power, an evaporator will prime unless handled carefully.

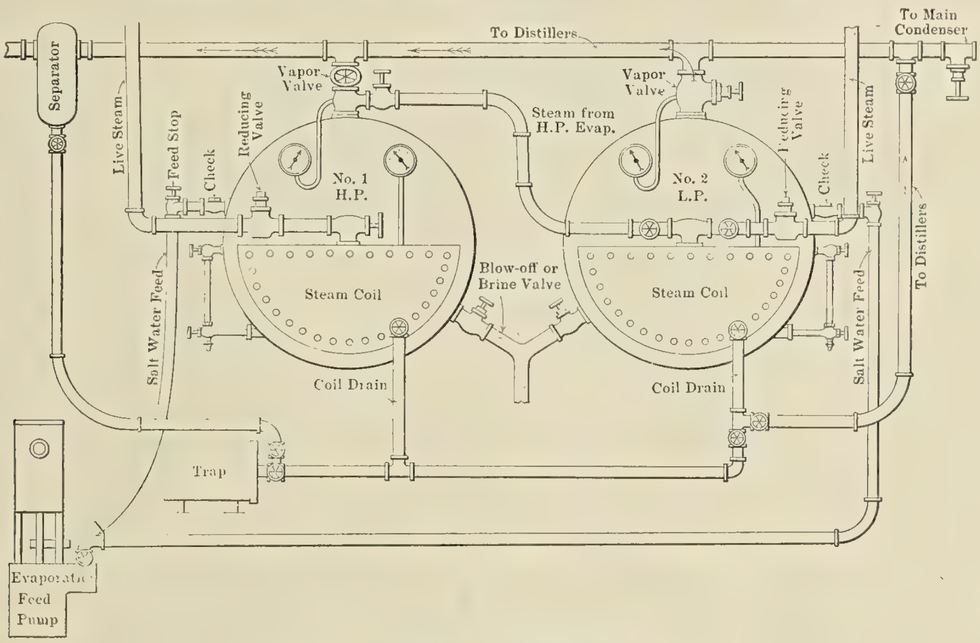


Fig. 3.—Multiple Effect Evaporator

When the distillers first discharge the water to the measuring tanks, it is there tested with silver nitrate as to its freshness. Generally, on starting of an evaporator, the first hundred gallons will run slightly salt. This is not fit for use on the boilers, but on some ships it is pumped into the crew's washroom tanks, or a water tank which is used for ship cleaning work. When the water comes fresh, it is measured, and then pumped or run to the reserve bottoms, or storage and trimming tanks.

It is advisable in operating to brine off—that is, to blow down the evaporator once every four hours. To do this, the vapor valve is closed and the shell pressure allowed to build up to 30 pounds, then the steam of the coil is shut off. The blow-off valve is slowly opened to full open and the shell is allowed to blow empty.

This carries out all the heavy brine and small lumps of salt scale, and is the best method to use. Some engineers prefer to blow down just a little each hour, but if the evaporators are required to be used steadily, the complete blow down method, coming at the end of each four-

hour watch, gives the steaming watch below a chance to clean fire while the evaporators are shut off for brining.

Fig. 3 shows the layout of piping for compounding two evaporators. The high-pressure evaporator, No. 1, uses live steam in its heating coils, and the vapor valves of the distiller line are so regulated that the vapor of this No. 1 high pressure evaporator is directed into the coils of No. 2, the low pressure evaporator, and after passing through the coils of this, it is then directed to the distillers. The object of this scheme is to get more distilled water per pound of coal used.

In operating in double effect, the coil pressure of the high pressure is carried at about 80 pounds; this gives about 45 pounds on the shell, and in turn we get the reduced pressures for the low pressure evaporator. The piping is so flexible in arrangement that both evaporators can be operated as high pressure or single effect.

In some evaporator plants there are fitted filters for the distilled water, and the feed pumps supply the evaporators through feed heaters, but general practice is to have the feed pump take its suction from the overboard discharge line of the distiller circulating water, which is quite warm.

It is economical to keep some water in the lower part of the evaporator steam coils. When running in single effect, this insures using all the heat of the steam and not bleeding live steam into the traps.

The evaporator coils will have to be removed at regular intervals for freezing of the salt scale, generally after 500 to 700 hours of use. Before removal, a large amount of the scale can be cracked off by filling the shell with cold water and allow to stand until the coil is cold to the touch. Then, as quickly as possible, admit live steam to the coil to 40 or 50 pounds; this produces sudden expansion, due to the rapid changes of temperatures of the coils, and cracks off a lot of the salt scale. There is but one drawback—it is apt to cause leaks in the joints if they be in poor condition. The shell is drained and the coil pulled out, then with scaling tools the balance of the scale is removed.

Coils should be tested, when out for cleaning, as to their tightness. When the boiler steam leaks into the shell space through leaky coils, if drinking water is being made, it becomes tainted with oil or boiler chemicals carried in the steam.

Forced Draft

There are several systems of forced and induced draft in marine use. The two which are most extensively used are the closed ashpit and induced draft, popular for fire-tube boilers, and the closed fireroom system used on many ships fitted with watertube boilers and many of the vessels of the navy.

Under normal steaming conditions, natural draft with all boiler power is best and most economical to use, but when the boiler power is reduced (such as when a part of the boilers are disabled for repairs or overhaul, or when there is a demand for increased speed above the regular standard capable with natural draft), the application of forced draft is a necessity. Some vessels are designed to operate at all times with induced draft, or the closed ashpit system.

A brief description of the two systems is given to acquaint the newcomer with what he may expect to meet with in working under them.

Closed Ashpit System

Large centrifugal fan blowers are so located that the air is delivered through a special heater installed in the uptake to a series of ducts that lead to the ashpits, which are tightly closed.

When charging the furnaces, the draft is cut off to prevent the flame and gases of the furnaces being forced out the fire door into the fire-room. The furnace and ashpan doors are fitted with automatic locking devices that take care of this.

The supply of air or pressure is regulated by varying the speed of the blowers and the thickness of the fuel bed. There is also fitted at the back of the ashpans a damper to be used in closing off the ashpit duct when operating under natural draft.

The Howden system uses retarders in the fire tubes—they consist of spiral-twisted thin metal strips that are inserted easily into the ends of the tubes. These insure the hot gases giving up all the heat by causing them to travel in spiral contact, thus retarding their egress.

All the air ducts and boiler casing must be frequently tested for leaks of the air pressure into the fireroom. Considerable saving is made by keeping these tight.

Induced Draft

In this system there is fitted in the base of the stack an exhaust fan that draws a current of air upward through the airs; it also uses closed ashpits, drawing the air, as in the previous system, through air heaters by means of ducts. The chief difference in these two systems is that the induced draft has no attendant danger of flare-backs when firing, as the air is drawn through the fire instead of being forced, as in the Howden system; also there is less trouble with leaks in the ducts and casings.

Closed Fireroom System

This is in general use on vessels of the navy, and has many inconveniences. All openings into the boiler room must be closed, for the air is discharged direct from the fan blowers into the fireroom. The only outlet for the air pressure is through the furnaces. In using this system, no changes are necessary to be made in the boiler to shift from natural to forced draft, but attention is required to get the fireroom ready. All hatches and doors are closed and dogged; all openings of the louvres of the bunkers used for vents must be closed.

In steaming with forced draft, the fires must be carried about 3 inches thicker than under natural draft. The rate of evaporation is much higher, and this calls for strict and careful attention in tending the water level. It should be two inches higher than for natural draft. Clinkers will form more quickly and plentifully, due to the increased coal consumption. It is therefore advisable to keep a small amount of water in the ashpans. The temperature of the fireroom is higher than under open conditions, and the men will find it harder to work under the air pressure. When the coal is fine and dusty, it will be to advantage to sprinkle it down before firing; this prevents it blowing around in the fireroom, and saves a large percentage from being carried up the stack.

To measure the air pressure created by the blowers, a draft gage is used, as shown in Fig. 2. The gage is of glass and is filled with water to the zero mark. One leg is open at the top to the pressure of air in the firerooms; the other is connected to a pipe leading to the atmosphere outside the firerooms. The difference in pressure is read in inches of water on the scale of the draft gage. For example, if the water is depressed one inch in *A*, and rises one inch in *B*, then the air pressure is two inches of water. One inch of water pressure is equal to two-thirds ounce pressure per square inch.

The writer finds it pays to wear goggles over the eyes while working in closed firerooms under forced draft.

The Service Department of a Shipyard*

Development of Service Department at Fore River Shipyard—Its Personnel and Functions—Reduction in Turnover of Labor

BY SAMUEL W. WAKEMAN

THE object of this paper is to describe a method of handling certain phases of shipyard work which has been successfully tried out in one large Eastern plant. Although some of the functions of this department are probably being carried out in the different yards to-day, we do not know of anyone who has treated this problem in just this manner.

About two years ago the president of the plant became interested in the enormous number of men that it was necessary to hire each month in order to maintain the working force then needed to carry out the work in hand. He determined that this problem must be solved and a committee was selected from the plant, composed of workmen, foremen and others. They made a tour of the country, visiting the following manufacturing concerns: "Link Belt Company, Sherwin Williams Company, Jeffery Manufacturing Company, Cleveland Hardware Company, Curtis Publishing Company, Chalmers Motor Company, Cleveland Foundry Company, Goodyear Tire & Rubber Company, Cadillac Motor Company, National Cash Register Company, Dodge Motor Company, Packard Motor Company, Ford Motor Company, Westinghouse Manufacturing Company, Carnegie Steel Company.

The most courteous treatment was accorded this committee at each of the above-mentioned plants, and the fullest information was given by them on all of the points which this committee investigated.

Recommendations of Committee

On their return they prepared a report of their investigations, together with such recommendations as to the betterment of the then existing conditions as they thought should be made, these recommendations including such ideas as the centralizing of employment instead of allowing each one of the different department heads to carry this on themselves. It also recommended that a new building be erected for this purpose; that a different point of view be taken with regard to applicants for positions, namely, their treatment should be as courteous and as fair as was possible to be given; that the housing and boarding situation be investigated; that all men leaving the employ of the company should be interviewed and given a chance to air their grievances. They further recommended a great many lines of activities to be encouraged in the plant and touched on many lines that had to do with the physical, mental and social condition of the employees. The recommendations of this committee were printed in pamphlet form and sent to about two hundred people in the plant. They were asked to freely criticise and, if possible, to make further recommendations. All of this information was then collected and formed the basis for the policy which is being pursued at the present time in regard to the service work in this plant.

A brick building was erected near the main gates of the plant to take care of the hospital work, the employment department, and the general activities of that nature. These activities were grouped under the name of Service Department, which, as its name signifies, is to render service to the employees of the plant. This department was put under the supervision of the general superintendent of the plant. The scope of its activities is as follows: Employment, hospital, safety work, educational work, apprentices, employees' club, works paper, suggestion committee work, yard restaurant, shop training.

Personnel

The personnel of this department consists of the following: Supervisor, assistant, clerks, stenographer, supervisor of instructors, instructors, employment agent, employment clerk, doorman, doctors, nurses, messenger boys for conducting applicants to shops.

In order to see clearly the relationship between the Service Department and the superintendents and foremen in the yard in regard to the supply of labor, the following illustration is used:

The ship carpenter may want ten pieces of 12-inch by 12-inch yellow pine 30 feet long. His requisition comes to the purchasing agent, who buys this material and has the same delivered to the ship carpenter. If on inspection by him three or four pieces out of the ten prove defective, he condemns this material and the purchasing agent replaces it. The ship carpenter decides what class of work this lumber can be used for and decides also whether the price paid for it is justified.

Requisitions for Labor

The same procedure holds for the supply of labor. A foreman finds he will need a certain number of men at a given time. He sends his requisition for this labor to the employment division of the service department. They send the required number of men to the foreman after interviewing these men and weeding out, so far as is possible, such applicants as would be incapable of carrying out the work for which they are required. These men are sent to the foreman of the department, who takes or rejects whatever number he may see fit and rates those he keeps, and those he rejects are sent back to the employment department, where an effort is made to place them in some other department in the yard where they may find work which they can do.

If the men hired are not satisfactory to the foreman, he may discharge them. In no particular are any of the foreman's prerogatives in regard to the handling of labor taken from him. The advantage of this method, however, is that the foreman is not compelled to interview a large number of men who have no qualifications for the work he is supervising, and his time is conserved for the more important duties he has to perform.

Examination of Applicants

Each applicant for a position is put through a careful physical examination by the company's doctor, and only such men are employed as are capable of doing the work for which they are hired. This has resulted in getting a very good class of men, and, where slight physical defects are found which can easily be remedied, the man is sent to the proper medical authority and taken care of. At first there was considerable objection on the part of some

* Paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1917.

of the men, but at the present time practically no one objects to the physical examination.

The employment department keeps an up-to-date requisition of all labor requirements of the plant, and takes such steps as are necessary, through its various sources of supply, to keep this requisition filled. It attempts to learn, by keeping in close touch with the various departments, the probable future needs for labor, which is a vitally essential factor in keeping a steady flow of men into the yard.

All applicants for work are quartered in a waiting room in the service building, equipped with chairs, and are interviewed in turn by the employment agent, being given a private interview in a separate room.

Book of Information for New Employees

Each applicant when hired is given a book which contains all the information about the plant that it is considered a new man should have. This book has been carefully prepared and gives the hours of labor, the method of tool delivery, certain safety suggestions, times and methods of payment of wages, and, in general, information in a condensed form which the new employee generally gets only after long association in the plant. This book has proven to be a great help to new men coming into the plant.

All employees transferred or leaving the employ of the company are required to be interviewed by the employment agent before they can obtain their wages. This provides an opportunity to place the man in a department where he may fit to better advantage than the one in which he was working, and also gives him opportunity to state any grievances he may have in connection with the company, his foreman or his work. These grievances are carefully tabulated and looked into and have been found to be a great source of valuable information in connection with controlling the feeling the employees have toward the company. All records for present and past employees are filed alphabetically in the employment bureau, and these records contain the name, age, trade, physical qualifications, address, place of past employment, rate, etc.

Daily Reports of Employment Department

There is a daily report prepared by the employment department, showing the number of men hired and leaving by trades, also daily gain or loss in the working force. The department also makes a monthly report of the turnover of labor, including the number of men hired and leaving by trades, showing the length of service and reasons for the man leaving.

One of the most important phases of the employment work is to provide proper housing facilities, and to this end the employment department lists, for the information of all applicants, boarding houses and available houses for sale or for rent.

If there is no position open at the time the applicant applies in person or by letter, an application card is filled out and filed by trades. All applications for employment are filed, and, as far as possible, the applicant is informed as to what date his services will be required, giving the minimum and maximum rate for the trade desired and the hours of labor.

Under the service department is a competent surgeon and an up-to-date hospital, where all of the accident cases in the yard are treated. The families of the employees may obtain free medical attention during certain hours of the day.

The safety work in the plant, which had reached a fair state of development, was combined with the work of the service department, and the different shop committees, together with the General Safety Committee, use this building as a meeting place where frequent talks by men who are specialists along this line of work are given to these men. Each department has its own safety committee, which makes periodical inspections and reports directly to the General Safety Committee. A great many ideas for work of this nature have originated in these committees and numerous appliances and safeguards have been adopted, due to suggestions received from them. All accidents are carefully investigated and the causes are immediately remedied; responsibility for accidents, as far as possible, is placed and steps taken to rectify them.

Educational Work

All of the educational work in connection with the training of apprentices and the training of men in the shops and different departments throughout the yard have been placed under the jurisdiction of the service department.

During the winter months, evening schools are conducted which provide training in naval architecture, mold-loft work, plumbing, coppersmith work, machine shop design, mathematics and blueprint reading. The instructors for these evening classes are, for the most part, drawn from the various departments in the yard and the instructions carried out under the direction of the local school board. These classes are open to any male beyond the age of sixteen in this locality and are attended by mechanics, apprentices and helpers to the number of about two hundred.

Apprentice Training

All of the work in connection with the apprentices in the plant is carried out under the supervision of the foremen in the different departments, but along the lines as laid down by the educational part of the service department, and the head of this department has been very successful in this connection with the attitude of the apprentice toward the company. Each year a dinner, to which prominent officials of the company are invited, is given by the apprentices, and efforts are made to promote the best of feeling among the young men who are being trained for future service in the company.

The service department supervises the publication of a works paper, which is issued every three months by the employees. This paper has developed to such an extent that its issue is awaited with a great deal of interest by all of the men in the plant.

Club House

The company presented to the employees of the plant a club house equipped with bowling alleys, rifle range, assembly and dancing hall, pool table, a band room and an athletic field where the different athletic teams practice and have their games. Quarters are provided for the athletic teams of the company in this building, with suitable shower baths, etc. This club is run entirely by the employees of the company, and only such necessary supervision is given to it by the service department as is absolutely necessary.

A restaurant is maintained inside the plant for the benefit of the employees. The supervision of this restaurant, although run by an outside caterer, is left to a committee of the employees who are in close touch with the service department.

Suggestion Boxes

One very important part of this service department work is the handling of the suggestions sent in by em-

- Head of Service Department
  - Employment Agent
    - Interviewing and hiring new employees.
    - Recruiting labor outside the plant.
  - Correspondence Clerk
    - Housing new employees.
    - Interviewing and recording departing employees.
  - Messengers (3)
    - Monthly analysis of employees hired and departed.
  - Recording Clerk
    - Recording on cards new employees
    - Daily report of men hired.
  - Door Man
    - Filing record cards of new employees.
    - Charge of main waiting room.
  - Assistant Stenographer 2 Clerks
    - Employees, Magazine
      - Associate editors.
      - Collection, compilation, proofreading, publication and distribution
    - Safety Work
      - Monthly statement of hours lost and percentage; accidents; recommendations approved; by General Safety Committee
      - Investigating and reporting special cases, bulletin posting.
      - Shop committees, organization and reporting.
      - General Safety Committee minutes.
    - Apprentices
      - Applications, tools, bonuses, and certificates
      - Shop Credit reports
      - General welfare, social activities, etc.
      - Book apprentices time and quarterly reports
    - Employees' Club
      - Minutes of meetings.
      - Publicity of activities.
      - Membership and dues.
      - Athletic activities.
    - General
      - Circulation of monthly periodicals.
      - Restaurant committee, supervision of yard restaurant.
      - Arrangement bulletin boards.
      - Naturalization assistance.
      - Navy League, rifle company.
      - Assistance to employees in promoting outings.
      - Information of any kind to employees.
    - Educational
      - Keep records of attendance.
      - Outline of curriculum
      - Receive applicants for classes.
    - Housing
      - Listing of lodging and rooming houses available for new men.
      - Information regarding houses for sale and to rent.
      - Advice to employees wishing to buy houses.
    - Suggestion Committee
      - Receipt and referring of suggestions to parties directly concerned.
      - After receipt of comments, action upon same by committee.
      - Recommendation of an award.
      - Notification to sender

Fig. 1

ployees. Boxes are placed throughout the yard and prizes are offered for suggestions sent in by the men. There is a great deal of work in connection with the proper understanding of what the employee means, the making of sketches, the referring of these suggestions to the proper people, so that they may be acted on, and the attitude which the men have toward this phase of the work must be carefully handled in order that the greatest amount of good may come from it. The work of this committee, of which the head of the service department is chairman, is one of the very important functions of this department.

Turnover of Labor

All of this work has begun to show results which it is felt can directly be traced to the work of this department. Statistics for many of the large manufacturing plants throughout the country that have attempted to increase their working force have shown that it is necessary to hire anywhere from seven to ten men in order to obtain one permanent employee. The latest results here have shown that it has been necessary to hire two men instead of from seven to ten in order to obtain one. When you consider that it is estimated that it costs somewhere between $20 and $35 to hire a new employee the result of cutting down the turnover in any plant means a tremendous saving in dollars and cents, although it may not always be possible to directly measure this.

Much of the reason for this decrease in turnover can be credited to the selection on the part of the service department; the hearty co-operation of the foremen, who have allowed a very liberal system of transfer from one department to another; the training of men into trades which they were not familiar with, and, in the main, to the general broad policy of the man directing the company.

Before the above plan was in operation, in order to maintain a force of about 4,000 employees, it was found necessary to hire, in the course of a year, 8,000 men. During the last six months the present force has been increased from 4,000 to 8,000, and this has been done by hiring 9,000 men. While these results cannot all be attributed to the work of this department, nevertheless it is felt that, in a large measure, the work which has been accomplished by them is responsible for a large percentage of this showing.

It is not claimed that any new or radical ideas have been adopted in connection with the handling of this situation, but what has been done is to find out what successful concerns in other lines of work have done and to combine them together in such a way that they might be adapted to the work of a shipyard. A man was employed who was thoroughly familiar with the sources of labor supply in the district in which this plant is located, and much credit is due him for the enthusiasm with which he approached this difficult problem.

An outline diagram showing the relationship of the different functions of this department to each other is shown in Fig. 1.

Tests of Oxyacetylene Welded Joints in Steel Plates

A series of tests of the strength of oxyacetylene welded joints in mild steel plates has been completed by the Engineering Experiment Station of the University of Illinois under the direction of H. F. Moore, Research Professor of Engineering Materials. Specimens were supplied by the Oxweld Acetylene Company of Chicago and tests were made in the laboratories of the station at Urbana under three conditions of loading: (*a*) static load in tension (in a testing machine), (*b*) repeated load (bending), and (*c*) impact in tension (in a drop testing machine).

For joints made with no subsequent treatment after welding, the joint efficiency for static tension was found to be about 100 percent for plates one-half inch in thickness or less, and to decrease for thicker plates. For static tension tests, the efficiency of the material in the joints welded with no subsequent treatment was found to be not greater than 75 percent. The joints were strengthened by working the metal after welding and were weakened by annealing at 800 degrees C. For static tests and for repeated stress tests, the joint efficiency sometimes reaches 100 per cent; the efficiency of the material in the joint is always less. This indicates the necessity of building up the weld to a thickness greater than that of the plate. The impact tests show that oxyacetylene welded joints are decidedly weaker under shock than is the original material; for joints welded with no subsequent treatment, the strength under impact seems to be about half that of the material.

In general, the test results tend to increase confidence in the static strength and in the strength under repeated stress of carefully made oxyacetylene welded joints in mild steel plates.

The results of these tests have been published as Bulletin No. 98 of the Engineering Experiment Station, copies of which may be obtained without cost by addressing C. R. Richards, Director, Urbana, Ill.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Loose Crank Pin

I noted with interest the way in which Andrew Lan, on page 511, the November issue of MARINE ENGINEERING, made his loose crank pin repair. It reflects credit on those who worked it out. The writer has, in several instances, dealt with the same trouble in a somewhat different way, and is passing this information along, not as new and original, but as old, and which may be of value to the younger engineer's notebook.

The center of the loose pin is drilled out and reamed tapered (a slow taper) to near full depth of the pin in the web, and a forged machine steel-tapered pin is then

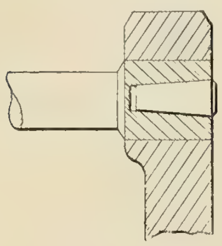


Fig. 1

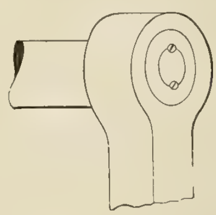


Fig. 2

driven, as shown in Fig. 1. The web and crank, contrary to belief, is not heated. The tapered pin is driven into it cold, and when it refuses to go any farther with square, heavy blows, it is cut off and doweled with screws on the face, as in Fig. 2.

The last repair made to a loose pin by the writer was nine years ago, to an 8-inch pin. A 2-inch hole was drilled, and a Morse standard taper reamer was used. The job is still running tight to-day.

Concord, N. H. CHAS. H. WILLEY.

An Understudy

Look about you for the youngster that's in love with the engineer and the plant—always grimy and dirty and happy—always glad to be called upon to help. He wants to be a real engineer—has always, from a kid. It's up to you, chief, to remember how you wanted a chance to learn when you started. When you see him, give him encouragement, take him in tow, give him a helping hand, and share with him your hard-earned kinks and experiences. Don't let him blunder along the hard road when you can set him right by a word or two. Discipline him when he needs it in a firm, kind way.

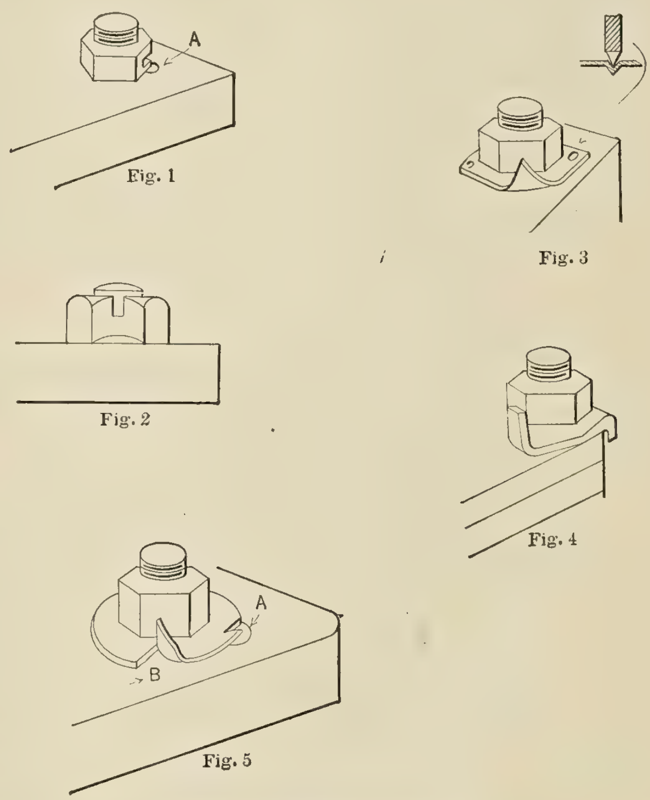
If there is such a young man in your plant, chief, make him an understudy, and do it earnestly. There will be a deal of satisfaction in feeling that you have trained such a youngster along the right path. Perhaps as the years pass by, he will do you great credit, and with the encouragement that you have given him he may become imbued with a stick-to-it spirit and desire to be a better engineer than his fellows. He may even aspire to fill the superintendent's or general manager's position of the fleet. His kind generally follow their ideal with unflinching zeal and eventually get there. You, then, chief, have a right to point to him and say: "See that young man filling the general manager's chair. Well, he used to be my understudy. I gave him a right start, and he's made good."

OBSERVER.

Lock Nuts

A few lock nuts that will be found handy for securing nuts of piston followers, cylinder heads, valve chest covers, etc., are shown in the illustrations. While these are not original with the writer, they are passed along for their worth.

Fig. 1 is a simple form. A slot is cut at the lower edge of the nut, and a prick punch impression is made on



Various Types of Lock Nuts

the machine, as shown at *A*. When the nut is tightened up home, the edge of the slot is bent down into this impression, thus securing the nut.

Fig. 2 shows the nut slotted at the top, and a radius filed on the bottom. When tightening down this nut, this radius at the bottom tends to flatten, thus closing the slot at the top, which pinches the stud.

Fig. 3 is a simple form of lock washer. A piece of flat stock is used as shown. When the nut is driven home on this washer, one corner is turned up flat against the side of the nut and the other corners are prick-punched deeply into the machine surface, as shown.

Fig. 4 is adaptable for corner or edge studs. A piece of flat stock is used for a washer. One edge is bent up against the nut, and the other edge bent over or down, as shown.

Fig. 5 is a common washer. A hole is drilled in the machine at *A* about 1/16-inch deep and ¼-inch diameter. The edges of the washer are turned up at *B* and down at *A* into the hole, thus securing the nut from turning.

Machinist Mate.

Packing Notes

High grade sheet packing is expensive stuff, and if waste of this can be prevented by the engineers, they will find that economy here receives a big boost. It pays to use the best packing obtainable, and suitable to the needs. In selecting a packing, there is but one kind to use, and that is the kind advertised in the trade journals as having stood the test. At the present time there is an abundant supply of varieties of packings, each one, of course, claiming the blue ribbon. It has always been true that wher-

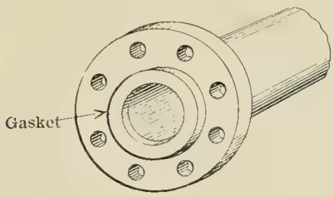


Fig. 1

ever the price is low the standard value of quality is also lowered.

There appears to be much chance for saving in packing expenditures on board the average ship, for where data were obtainable the packing expense was very excessive. Perhaps the largest source of waste, and the easiest prevented is that of allowing every Tom, Dick and Harry to cut out a gasket. It is safe to say that more than 50 percent of ship's engineers allow coal passers and firemen, when they are being used as helpers on repair work, to do so. These men usually have no idea of packing values, and they hack out a gasket most any old way, wasting considerable by improper laying out and cutting.

When the flange of a joint is of sufficient width or face inside the bolt circle, much material is saved and a better joint made by cutting the gasket to fit, as shown in Fig. 1.

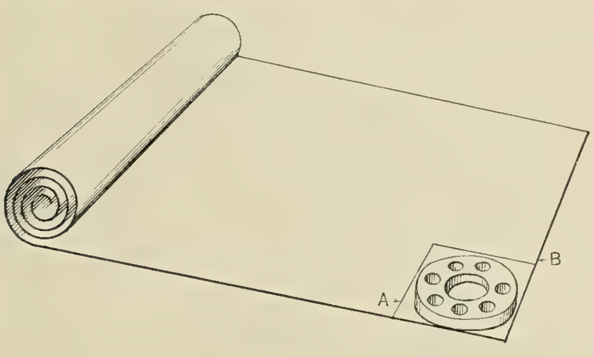


Fig. 2

When tightening up on such a gasket, the full strength of compression is exerted upon it, whereas in a full face one, that portion outside of the bolt circle often has to be squeezed thin by extra force on the bolts in order to make a tight joint.

Fig. 2 shows the best way to lay out a gasket. A template of the flange is laid on the packing and its outline scribed. The template should be placed as shown, as close to the edges of the sheet of packing as possible. Fig. 3 shows a large cylinder head gasket; the center section of

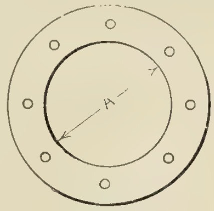


Fig. 3

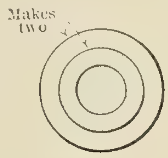


Fig. 4

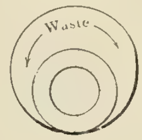


Fig. 5

this at *A* can be saved to make smaller gaskets, as in Fig. 4.

Many men waste packing when cutting from these circular pieces, as shown in Fig. 5. When making square

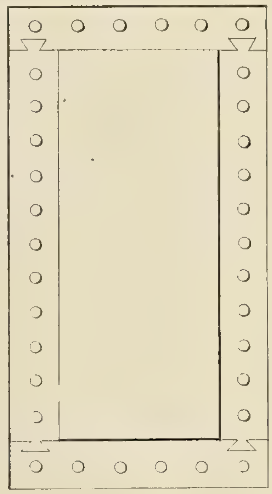


Fig. 6

or rectangular shaped valve chest cover gaskets, the narrow strips that would be otherwise wasted can be cut as shown in Fig. 6, dovetail at the ends. The dividers and rule are very reliable in the hands of a good man for laying out circular gaskets. But when a template can be had, it is the best method to use.

Fig. 7 shows the old and much abused method of marking out with a ball peen hammer an impression of the

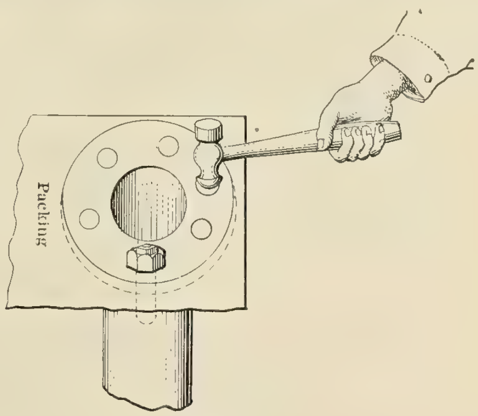


Fig. 7

joint flanges. A very good facsimile of the flange and bolt holes can be made in this manner, and then the gasket cut with proper tools on a block of wood. It is dead wrong to hack out expensive packing with a hammer over the edges of a flange. Such a method is only justified

when rush emergency work makes this quick method essential.

Fig. 8 shows a gasket with two ears or tabs left in cutting for the purpose of aiding in inserting the gasket in place between tight flanges in close, hot and uncomfortable quarters. These ears are made by leaving the corners *A* and *B*, in Fig. 2, a part of the gasket.

Fig. 9 is another method of inserting the gaskets in tight places. Often there is a leak in a valve of the line,

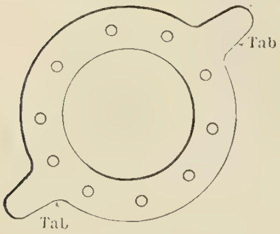


Fig. 8

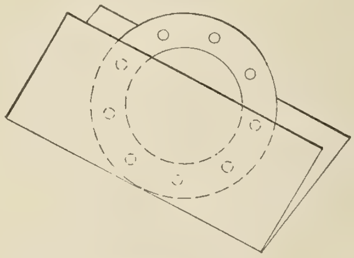


Fig. 9

and it is next to impossible to work next to the joint with one's hands. A thin sheet of paper brass, bent as shown, will pass through the joint, and as the upper part of the gasket gets in place, a bolt is slipped through the hole, and this holds it in place while the brass is withdrawn.

Fig. 10 is a sketch of a very handy gasket saw. The frame is made of pipe, flattened and bent, as shown. The

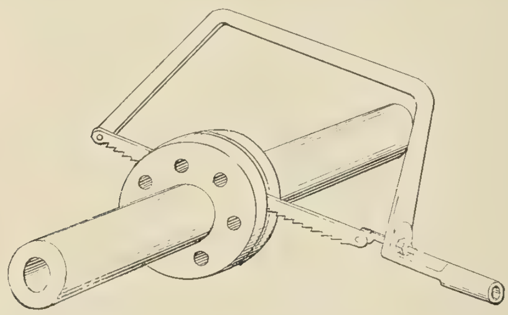


Fig. 10

purpose of this saw is to tear out the old gasket that always adheres like glue to the flange faces. After the saw clears the way, then a packing knife or scraper, made of an old hack saw blade, is used to clean the faces of the joint, one of which is shown in Fig. 11.

Fig. 12 shows very handy gasket trimming and cutting tool easily made from old files. Fig. 13 shows a die and

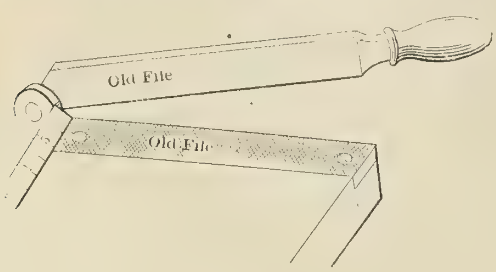


Fig. 12

punch made of an old round file and piece of machine steel. The bolt holes are cut clean at one blow when cut with such a tool. Fig. 14 is a cow mouth, or gouge chisel used to cut round corners, etc., made from a short piece of an old 14-inch flat file. The cow mouth shape is forged on the horn of the blacksmith anvil.

Sometimes one runs across a stubborn joint that, in spite of considerable attention, will leak or blow out. This kind of joint requires care and patience to make it tight. If ordinary packing does not hold, then the flange should be tested for trueness, and, if possible, a groove should be cut in the face of the flange into which the packing will squeeze, making it a male and female type of joint.

The most troublesome joint that the writer had to deal with in his experience was that of a high pressure feed water heater head. This head pulsated at each stroke of

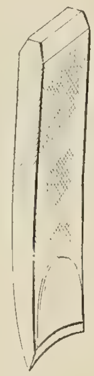


Fig. 14

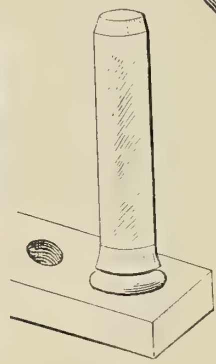


Fig. 13

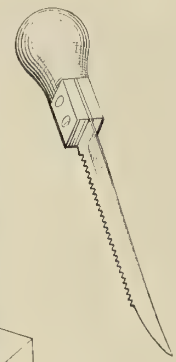


Fig. 11

the feed pump, and in spite of reinforcing with stays it would continue to throb and cause the joint to leak. After trying all the various thicknesses and kinds of packing, and having no luck, we resorted to making the joint with two thicknesses of fine brass wire mesh, coated on both sides heavily with red lead and litharge. This surprised us by holding tight, after allowing it to set. The main objection to this sort of gasket is the trouble experienced in breaking the joint when necessary to do work on the machinery.

Concord, N. H. C. H. WILLEY.

The Liberty Mill

(*Concluded from page 33.*)

ments is completed, the method of heating will be by by-product gas from the Clairton coke ovens in conjunction with a small quantity of tar.

The mill rolls plates up to 100 inches wide and 3/16 inch up to 2 inches thick. It rolls from slabs and sufficient steel for it is not available at present from the Homestead furnaces. The slabs come from Farrell Steel Works & Furnaces, Ohio Steel Works & Furnaces and Donora Steel Works & Furnaces, together with such miscellaneous slabs as can be taken from the present Homestead slabbing mills.

The best production to date is 266 tons, single turn, ten hours, with six furnaces. With an ample supply of steel and orders of a character suitable for maximum production, it will make 16,000 tons per month.

The cost of the mill will approximate $2,500,000 (£512,500), including therein the cost of the new gas engine, generator, etc., at Carrie Furnaces. On double turn it will employ approximately 250 men.

The average number of men employed under Homestead Steel Works organization in October, 1917, was 12,132, and the production of steel ingots was about 200,000 tons. This is not the maximum production for this plant. Tonnage has been reduced by reason of transportation difficulties, lack of coke, labor, etc.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number if from examination for grade of chief, and by a dagger (†) if from examination for other grades.

Stephenson Link Motion

Q. (929).—What is the difference between the two arrangements of Stephenson link valve gear known as open and crossed rods? When either type of link is used with an outside valve, what are the effects of linking up upon angular advance, valve travel and lead?

A. (929).—A Stephenson link valve gear is known as an open gear, or gear with open rods, if when the crank is turned away from the cylinder the rods are open as

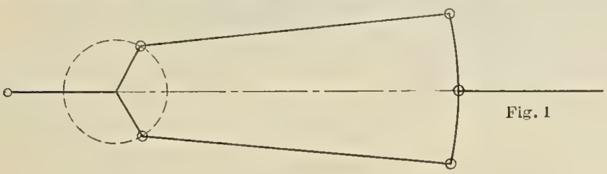


Fig. 1

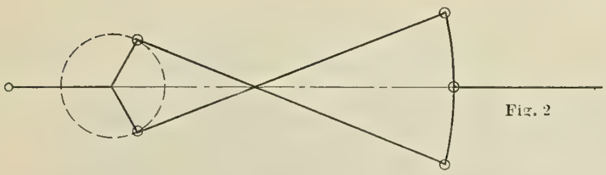


Fig. 2

shown in Fig. 1. A Stephenson link valve gear is known as a crossed gear, or a gear with crossed rods, if when the crank is turned away from the cylinder the rods are crossed as shown in Fig. 2.

Effect of linking up:

	Open Rods	*Crossed Rods*
Angular advance............	Increased	Increased
Valve travel................	Decreased	Decreased
Lead	Increased	Decreased

The above effects are produced when an outside valve is used. When used with an inside valve, lead is the only characteristic of those under discussion affected, and it is decreased and increased respectively for open and crossed rods.

Piston Valves

Q. (930).—What is the chief advantage of the piston valve over the flat slide valve? When are piston valves employed?

A. (930).—The great advantage of the piston valve over the flat slide valve lies in the fact that it is perfectly balanced as regards the steam pressures which act upon it, and, therefore, moves with only such frictional resistance as may be necessary to insure tightness against steam leaks.

Piston valves are used when the steam pressures in the valve chests are high; with this type of valve the frictional load is less than with the flat slide valve. The high pressure and intermediate pressure cylinders of a triple expansion marine engine are usually fitted with this type of valve, and very frequently it is also the case with the low pressure cylinder.

Saturated Saline Solution

Q. (927).—With a solinometer at 12/32ds, will it rise any more?

A. (927).—The salinometer will not indicate a greater reading than 12/32, because at this density (really at 10/32) the liquid is a saturated solution. Any additional saline matter will not go into solution, but will be deposited.

Radial Type Valve Gear

Q. (933).—What are the chief advantages of the radial type of valve gear?

A. (933).—The chief advantages of the radial type of valve gear are: The length of the engine as a whole may be less than with the Stephenson link, as the cylinders may be placed near together, they possess the property of giving the same lead for all points of cut-off.

Effects of Changes in Valve Gear

Q. (934).—Explain the influence on the various events and items due to change in the three items, angular advance, steam lap and exhaust lap.

A. (934).—The answers to this question may be determined from the table:

Angular Advance	Increase	Decrease				
Steam Lap.......	....	....	Increase	Decrease		
Exhaust Lap......	....	....	....	....	Increase	Decrease
Steam Opening....	Earlier	Later	Later	Earlier	....	....
Steam Closure....	Earlier	Later	Earlier	Later	....	....
Steam Lead.......	Increase	Decrease	Decrease	Increase	....	....
Exhaust Opening..	Earlier	Later	....	....	Later	Earlier
Exhaust Closure...	Earlier	Later	....	....	Earlier	Later
Exhaust Lead.....	Increase	Decrease	....	....	Decrease	Increase
Greatest Port Opening........	Same	Same	Decrease	Increase	....	....

Capacity of Coal Bunker

Q.* (938).—How many tons of soft coal will a bunker 26 feet by 3 feet by 5 feet 2 inches contain?

A. (938).—Assuming the bunker to be rectangular, its capacity is $26 \times 3 \times 5.17 = 403.3$ cubic feet. The average of a large number (328) of weighings of various American bunker coals gave $42\frac{1}{2}$ cubic feet = 1 ton. Customary values for calculation are 43 and 44 cubic feet = 1 ton. Using the former we get the capacity of the bunker to be $403.3 \div 43 = 93.8$ tons.

Capacity of Rectangular Tank

Q.* (939).—How many gallons of oil will a rectangular tank 3 feet 4 inches long, 32 inches wide and 5 feet 4 inches high contain?

A. (939).—The contents of the tank are $40 \times 32 \times 64 = 8,192$ cubic inches. There are 231 cubic inches in one U. S. gallon, therefore there are $8,192 \div 231 = 35.5$ gallons.

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ON BOARD A FIRST CLASS AMERICAN BATTLESHIP

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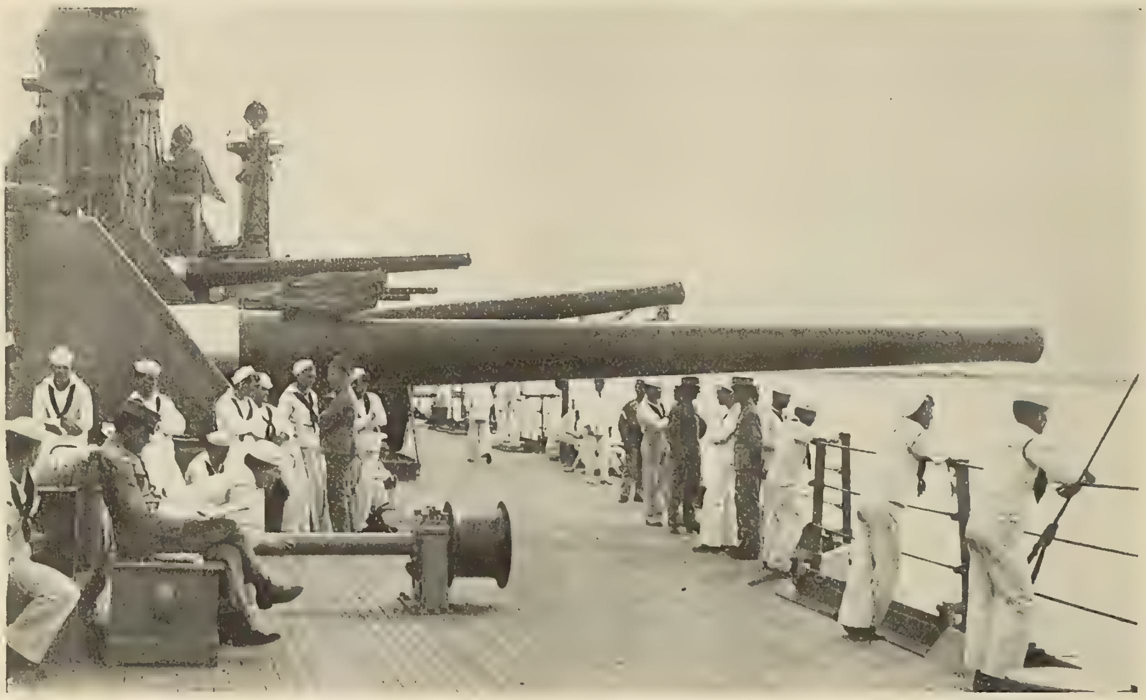

After Deck, Showing Main Battery

Physical Exercise Forms a Part of the Daily Routine of the Crew

Shipbuilding and General Marine News

**Contracts for New Ships—Shipyard Improvements—
Engineering Projects—Improved Appliances—Personal Items**

CHAS. PIEZ NOW GENERAL MANAGER OF EMERGENCY FLEET CORPORATION

Resignation of Admiral Harris Causes Another Change in Organization

Charles Piez, vice-president of the United States Shipping Board Emergency Fleet Corporation, has been appointed general manager of the corporation, succeeding Rear Admiral F. R. Harris, who resigned shortly after his appointment to this post. It is now believed that the reorganization of the Emergency Fleet Corporation is nearly completed.

The appointment of Mr. Piez was made by Chairman Hurley with the object of speeding up the actual production of ships. Due to the fact that Mr. Piez had been head of the Production Committee of the Fleet Corporation, and had first-hand knowledge of the actual conditions in the yards as a result of careful study of conditions in the field, it is believed that the best results can be obtained by combining the functions of the vice-president of the organization with those of general manager.

Mr. Piez, who is about 51 years old, is a graduate of the Columbia School of Mines, New York City, class of 1889. His business and engineering career has been associated with the Link Belt Company, manufacturers of elevating, conveying and power transmission machinery, of which he has been president since 1906. In addition to personal and professional achievements, Mr. Piez has been very active in rendering public service. He was a member of the commission that developed the Illinois Factory Act in 1909, and the following year acted as chairman of the Illinois Workman's Compensation Commission.

New Building for School of Naval Architecture to Be Constructed at Massachusetts Institute of Technology

The Massachusetts Institute of Technology, Cambridge, Mass., is to begin at once the erection of the Pratt School of Naval Architecture and Marine Engineering building.

Charles H. Pratt, a Boston lawyer, left the bulk of his estate to the institute for this purpose, stipulating that the trustees should hold the fund until it amounted to $750,000. The fund now exceeds that amount by $100,000. The erection of the building has been deferred until this time on account of the high cost of materials and labor, but is now undertaken as a patriotic duty on account of the urgent demand for naval architects and draftsmen.

Shipbuilding Companies Consolidated

The Pusey & Jones Company, Wilmington, Del., has increased its capital stock from $1,250,000 to $20,000,000, and will take in the Pennsylvania Shipbuilding Company and the New Jersey Shipbuilding Company, which have adjoining plants at Gloucester, N. J. The three companies are largely owned and controlled by Christoffer Hannevig, 139 Broadway, New York, a Norwegian capitalist.

Are You the Man?

Skilled workers are needed at once in the air service behind the lines in France. Squadrons have been and are now being formed for this service. Picked men are being enrolled from the various workers; these men will be given special training, according to their vocations, in the work required in the air service. They will get actual practice work on airplane motors, trucks, airdome construction and everything that will be done on the other side.

If you operate a lathe, drive a truck, splice insulated wire, fit a joint, or do other skilled work better than the average—perhaps you are the man! Skilled men will be enrolled as non-commissioned officers, ranking as sergeants and corporals, with pay ranging from $30 to $81 per month, according to rank. You will be right up behind the lines—as near the front as the airdomes can safely be taken.

The kind of men wanted includes chauffeurs, auto mechanicians, carpenters, electricians, coppersmiths, sailmakers, machinists, blacksmiths, metal workers, draftsmen, tool makers, welders, plumbers, painters, pattern makers, boat builders and a host of other skilled workmen.

Talk this over with your friends. Team up with your "pal," go to the nearest army recruiting station and enlist in the aviation section of the Signal Corps.

Germany to Give Subsidy for Merchant Shipbuilding

A Berlin dispatch says the Reichstag has adopted a bill for restoration of the German merchant fleet. The bill provides for a State subsidy to shipowners for reconstruction of merchant vessels.

New Coastwise Line

It is reported that a new coastwise steamship line has been organized to ply between San Francisco, Southern California, Mexico and Central America. Details have not been made public.

DISCLOSURES AT SHIPPING BOARD INQUIRY

1,427 Vessels of 8,573,108 Deadweight Tons Under Construction or Contract

According to figures given by Edward N. Hurley, chairman of the Shipping Board, before the Senate Investigating Committee, 1,427 merchant vessels of 8,573,108 deadweight tons are under construction or contract. Of these, 431 ships of 3,056,000 tons were under construction or order by private or foreign owners when the Government commandeering order went into effect on August 3. The new tonnage of steel vessels ordered is represented by 559 ships of 3,965,200 deadweight tons. The wooden ships contracted for include 379 vessels of 1,344,900 deadweight tons, while the contracts for composite ships comprise 58 vessels of 207,000 tons.

Since the commandeering order went into effect 49 vessels of a total of 300,865 deadweight tons have been completed and put into service. Before the commandeering order was issued 15 ships were delivered to foreign owners.

The prices for the various types of vesels average as follows: Steel ships, $166.48 a ton; wooden ships, $84.87 a ton (exclusive of machinery); composite ships, $133.97 a ton.

An analysis of the statistics supplied to the investigating committee by Rear Admiral F. T. Bowles, assistant manager of the Emergency Fleet Corporation, shows that on December 1 the emergency shipping programme, calling for the construction of 8,246,308 tons, was 18.2 percent completed.

The contracts of the Emergency Fleet Corporation have been let to 110 shipyards, of which 36 existed on January 1, 1917, and 74 have been created since. In addition the Emergency Fleet Corporation has requisitioned vessels which are building in 32 yards in addition to the above, so that the Emergency Fleet Corporation is at present controlling work in 132 yards, of which 58 are old and 74 are new.

This vast programme of construction was superimposed on a naval programme which was the equivalent in dollars, and therefore in shipbuilding effort, for the construction of 2,500,000 tons of merchant shipping.

The naval programme and private contracts absorbed practically 70 percent of the eighteen prominent shipyards in existence at the beginning of the war with Germany, the remaining 30 percent of these yards being taken up with the construction of merchant shipping for both foreign and domestic account. This tonnage is now being completed under the supervision and control of the Emergency Fleet Corporation.

Shipbuilding Notes

The Submarine Boat Corporation, 11 Pine street, New York, has received an order from the Emergency Fleet Corporation, Washington, D. C., to build 100 additional vessels of 5,000 tons each. This company now has contracts for 150 vessels from the Government, valued at approximately $110,000,000.

The Emergency Fleet Corporation is planning to have from fifteen to twenty-five sea-going tugs built as soon as possible for the New England coal trade.

The United States Shipping Board has approved an appropriation of $3,360,000 to be used in building barges and tugs for use on the Mississippi River.

The Union Iron Works, San Francisco, Cal., has received a contract from the Atlantic Refining Company, San Francisco, to build two oil tankers of 7,445 gross tons each.

It is reported that the American International Shipbuilding Corporation, 120 Broadway, New York, will shortly begin the construction of seventy troop ships for the United States Government. According to report these vessels will be of 8,000 tons displacement.

The United States Steamship Company, 50 Broad street, New York, is reported to have received a contract, aggregating $18,000,000, from the Emergency Fleet Corporation, to build steel and wooden vessels. In order to meet the requirements of this contract the company has purchased a location for another shipyard, which is to be located at Alexandria, Va.

Among the recent contracts arranged by the Emergency Fleet Corporation are the following:

With the Foundation Corporation, 233 Broadway, New York, twenty 4,000-ton steel unsinkable ships from designs made by a French naval constructor. It is reported that a vessel of this type successfully resisted five torpedoes dicharged into her sides.

With the Erickson Engineering Company, Seattle, Wash., ten 9,500-ton steel steamships.

With the American Shipbuilding Company, Cleveland, Ohio, thirty-six 3,500-ton steel ocean-going steamships. These will be built at the South Chicago, Ill., plant.

With the Southern Shipbuilding Company, which will build a shipyard near Charleston, S. C., and of which H. N. Whittlesey, 17 Battery Place, New York, is president, sixteen fabricated steel vessels. The amount involved in the contract is said to be $20,000,000.

With the Federal Shipbuilding Company, 71 Broadway, New York, which is owned by the United States Steel Corporation, ten 9,400-ton steel steamships.

With the Newburgh Shipyards, Inc., Newburgh, N. Y., four 5,000-ton steel steamships.

With the Los Angeles Shipbuilding & Dry Dock Company, Los Angeles, Cal., ten steel steamships in addition to those already contracted for.

With the Patterson-McDonald Shipbuilding Company, Seattle, Wash., eight 8,000-ton steel steamships.

The Matson Navigation Company, San Francisco, Cal., is planning to build new steamships to take the place of the three which have been requisitioned by the Government.

The Keystone Steel & Wire Company, Peoria, Ill., will build two steel towboats and 14 steel barges.

The Columbia Engineering Company, Portland, Ore., is reported to have received a contract from Christoffer Hannevig, Inc., 139 Broadway, New York, to build two wooden auxiliary schooners.

Mathew Bros., Belfast, Me., have received a contract from Crowell & Thurlow, Boston, Mass., to build a five-masted schooner.

The Saginaw Shipbuilding Company, Saginaw, Mich., expects to begin work immediately on the first of six ships, orders for which have been received from the Government.

Shipyard Notes

The Pennsylvania Shipbuilding Company, Gloucester, N. J.; the New Jersey Shipbuilding Company, Gloucester, and the Pusey & Jones Company, Wilmington, Del., have consolidated. Christoffer Hannevig, 139 Broadway, New York, will be president of the new company, the name of which has not yet been made public.

E. H. Gary, chairman of the United States Steel Corporation, 71 Broadway, New York, referring to the shipyard at Mobile, Ala., to be established by its subsidiary, the Tennessee Coal & Iron Company, states that ten shipways will be laid down immediately and that large wharves will be built, including power plants, boiler shops, etc. The total investment will be in the neighborhood of $15,000,000.

The Slidell Shipbuilding Company, Slidell, La., has been reorganized under the name of the Louisiana Shipbuilding Company, and its capital increased to $1,500,000.

The Merrill-Stevens Company, Jacksonville, Fla., has reorganized under the name of the Merrill-Stevens Shipbuilding Corporation, and its capital stock has been increased to $5,000,000.

The Hampton Roads Shipbuilding & Dry Dock Company, Norfolk, Va., has purchased 150 acres for the site of its shipbuilding plant.

The Gulf Shipbuilding Corporation has been incorporated, with a capital stock of $1,000,000. George V. Reilly, Arthur W. Britton and S. B. Howard, 65 Cedar street, New York, are the incorporators.

The Pacific Coast Shipbuilding Company, San Francisco, Cal., is now fully organized and has begun work on its plant at Bay Point. The company owns 2,100 acres of land. It is reported to have received a contract from the Emergency Fleet Corporation to build ten 9,400-ton steel steamships.

The International Navigation Company, W. H. Garland, president, Wilmington, N. C., has purchased 600 acres of land on the Cape Fear River as a site for a shipyard.

M. M. Davis & Son, Inc., Solomons, Md., have taken over the shipbuilding plant formerly operated under the name of M. M. Davis & Son, and are planning to increase its capacity. The New York office of the company is 366 Fifth avenue.

The Ketler-Ellicott Erection Company, Chicago, Ill., is planning to build shipyards. It is reported to have already received contracts for ten steel ships.

The Houston Shipbuilding Company, Houston, Tex., has secured a 5-acre tract of land near Harrisburg, where it will build its yard for the conctruction of ocean-going ships. Arthur Boyce, Dallas, Tex., is president.

Clement M. Egner, Elkton, Md., and associates, have incorporated the Ethel Ship Corporation.

C. Bruno Carlson and associates, San Francisco, Cal., have incorporated the Golden Gate Shipbuilding Company.

The American Shipbuilding Corporation has been incorporated at Alexandria, Va., with $10,000,000 capital. Colon H. Livingstone, 1249 Kenyon street, N. W., Washington, D. C., is president.

Alfred E. Norton, C. Nordstrom and Elmer E. Wigg, Bloomfield, N. J., have incorporated the Norton Shipbuilding Company.

It is reported that the Oceanic Shipbuilding Company, Portland, Ore., will build a shipyard at Milwaukee, Ore.

The Jancke Shipbuilding Company, Madisonville, La., is planning to build a shipyard, and is reported to have received a contract from the Emergency Fleet Corporation to build several steel steamships.

The Golden Gate Shipbuilding Corporation has been organized in San Françisco, Cal. Among the incorporators are C. B. Carlson and Victor O. Post, Oakland, and J. E. Pembert, Berkeley.

The Hydro-Submersible Corporation of America has been incorporated to manufacture submarine boats. The incorporators are Harold T. Montague, Everett A. Fretz and Reynolds O. Gilke, all of Philadelphia, Pa.

It is reported that the Government is planning to spend about $3,000,000 at the yards of the Groton Iron Works at New London and Noank, Conn.

George L. Craig, of the Craig Shipbuilding Company, Long Beach, Cal., is reported to be planning the construction of a new shipyard at San Diego.

The Martinolich Shipbuilding Company has been incorporated at Seattle, Wash., by John Martinolich and C. E. Papst.

The Da LaVergne Machine Works, foot of East 138th street, New York, has been sold to the William Cramp & Sons Ship & Engine Building Company, Philadelphia, which will use it for the manufacture of marine oil engines and refrigerating machinery.

The Racine Boat Company, Racine, Wis., and the Simmons Boat Company, Chicago, Ill., have been consolidated.

The Louisiana Shipbuilding Company has been organized at Richmond, Va. No details have been made public.

Russian Ship Registry Bureau

An organization shown as the Russian Register is in operation in Russia for the registry and classification of vessels on the inland waterways. This institution was established by nine leading transportation and insurance companies. Since its institution two more companies have joined.

Up to October 1, 1916, the number of vessels, without steam power, examined by the Russian Register was 1,363, having a total deadweight of 1,854,672 tons. The total number of vessels of this kind registered by the Russian Register was 3,499, having a total deadweight of 3,817,184 tons. The number of vessels having steam power registered up to January 1, 1916, was 1,103, with a total of 255,434 indicated horsepower.

Skinner & Eddy Launch First Ship for United States Shipping Board

Before 15,000 spectators the steamship *Seattle,* the first ship to take the water under the United States Shipping Board's contracts, was launched at the plant of the Skinner & Eddy Shipbuilding Corporation, Seattle, Wash., on Saturday, November 24, at 12:30 P. M. To commemorate the event the Shipping Board permitted this ship to be christened with the name of the city which had turned out their first product.

Under the Shipping Board contracts the *Seattle* received the official number 83, that many contracts having been awarded before the Skinner & Eddy Corporation received their six. As the *Seattle* is patterned after the same design as the other 8,800-ton cargo carriers turned out by that plant, everything was ripe for a speedy delivery of this ship, and within 77 working days after the keel was laid, Dave Rogers, the works manager, and his band of loyal workers had this ship in the water.

The sponsor for the *Seattle* was Mrs. Ernest Lister, wife of Governor Lister of Washington.

The *Seattle* is the eleventh ship turned out by the Skinner & Eddy yard in less than twenty months, number 10 being the *War Flame,* which was launched in 64 working days from the day the keel was laid, thus establishing a world's record for the construction of ships of the 8,800-ton deadweight class.

At the same moment the *Seattle* was launched the Ames Shipbuilding & Dry Dock Company, of Seattle, launched their first product, which is called the *War Brigade.*

Two more launchings are scheduled at the Skinner & Eddy plant before December 31, and during the next year it is expected that more than fourteen ships will be sent down the ways at this plant.

Officers the Greatest Need of the Navy

At the recent graduation of 192 ensigns in the naval reserve the Secretary of the Navy stated that on September 1, 1916, the total enlisted strength of the Navy and Marine Corps, including men and officers in the regular service and in the reserve ranks, was 74,542. On September 1, 1917, the number was 232,930. We have to-day in the navy all the men we need until ships under construction and repair are furnished and put in commission. The greatest need, therefore, is for officers who know how to sail a ship, how to man its guns, how to organize it to fight.

Since the war began the Naval Academy has been doubled, but to-day its facilities are inadequate to graduate officers as rapidly as they are needed. This, too, after we graduated two classes this year. Other sources, therefore, must then be relied upon for officers in emergency.

The first reliance is upon retired officers who have Naval Academy training, but who have been retired by the age limit or for some illness that did not enable them to perform all the duties of a naval officer afloat or ashore.

The second source of supply for capable naval officers is from the ranks. Within the past two months 794 capable men have been commissioned as ensigns or junior lieutenants, and from this wonderful body of exceptional warrant officers the navy will find men worthy of the commissions they have earned.

The third source to which the navy looks for officers is to the well-organized Naval Militia.

Southern School of Nautical Sciences Opened

A College of Nautical Sciences, with about fifteen instructors on the faculty, was recently opened at 6363 St. Charles avenue, New Orleans, La., offering to young ment of the South an opportunity to study ship drafting, marine engineering, ocean navigation and seamanship.

The course in ocean navigation will cover a period of five months, and the courses in ship drafting and marine engineering periods of seven months each. The classes will be held in the evening, enabling young men to engage in shop or engine-room practice, so as to combine the practical with the theoretical side of the vocations.

To meet the needs of the rapidly-growing shipping and shipbuilding industries in the Gulf States this school will fill a most important mission, and it is expected that the attendance to the classes will be large, as no less than ninety men applied for admission at the opening of the school.

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Photograph Taken from British Airplane, Showing Effect of Bombs Dropped on on Marine Terminals of Enemy Seaport

Nearly 10,000 Lives Lost on British Merchant Vessels

It is announced that the number of lives reported as lost on British merchant vessels owing to enemy action from the beginning of the war until June 30 last is 9,748.

SKILLED MECHANICS WANTED IN GOVERNMENT NAVY YARDS

Ship Fitters, Anglesmiths, Blacksmiths and Machinists Especially Needed

The United States Civil Service Commission issues the following:

Nearly 55,000 appointments were made to the forces of mechanics, helpers and laborers at navy yards and other naval establishments during the fiscal year ended June 30, 1917, and since that date appointments have been made in increased proportion.

An appropriation of $7,500,000 is now being expended in the enlargement of the great naval gun factory at Washington, which, when completed, will furnish employment for 4,000 or more skilled mechanics, in addition to the 8,000 already at work in the plant. In this mammoth factory, one of the best equipped and most interesting in the world, are built the great guns for our war vessels, which carry to every country the message of America's ability to protect herself and to safeguard the rights of her citizens wherever they may be.

Philadelphia Aircraft Factory

The new naval aircraft factory at Philadelphia, which will be completed this month, will also employ about 3,000 men.

The workers who man such plants are of a superior class, and they feel a personal pride in turning out products that will stand the test of conflict with the arms of other nations. A considerable part of the building of war vessels is also done in Government yards.

The United States Civil Service Commission, which is charged with the task of recruiting the ranks of this great

civilian army, through its widespread organization, is furnishing the men as they are needed. In certain trades, particularly those connected with shipbuilding, there is usually a shortage. Sailmakers, coppersmiths, ship fitters, anglesmiths, blacksmiths and machinists are especially neded. Women to operate power sewing machines are also in great demand.

Urged to Offer Services

The representatives of the Civil Service Commission at the postoffices in all cities are the official recruiting agents for this as well as other branches of the civil service. The Commission urges competent mechanics to offer their services to the Government at this time of great need.

Type 4-1000 Oxygen-Hydrogen Generator, Manufactured by the International Oxygen Company

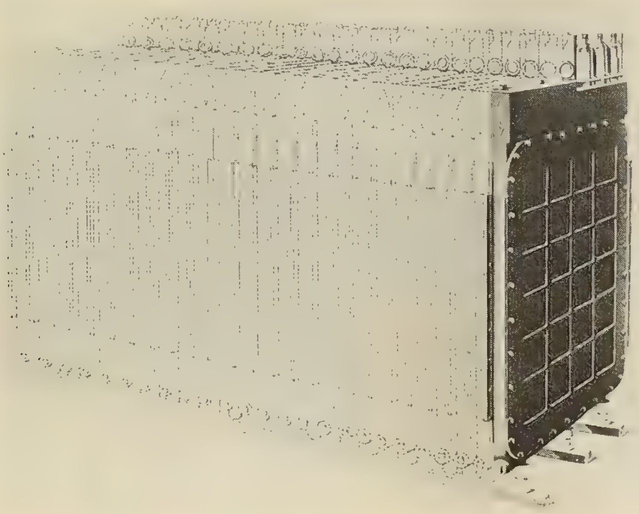
In this new electrolytic gas generator the manufacturers have adopted no new scientific principles but have introduced such radically-new departures in the construction features as to have created an entirely new type of apparatus. The most conspicuous feature of the Type 4-1000 cell is its compactness—the dimensions being approximately 3½ inches thickness, 3½ feet width and 6 feet high. The capacity of this cell, under 1000 amperes of current, is approximately 200 cubic feet of oxygen and 400 cubic feet of hydrogen per 24 hours, this generating capacity requiring almost exactly 1 square foot of floor space. The illustration indicates the size of a battery of 25 cells with a total 24-hour capacity at 1,000 amperes of 5,000 cubic feet of oxygen and 10,000 cubic feet of hydrogen, the floor space requirement being about 3½ by 7½ feet.

The second unique feature of the Type 4-1000 generator is its operating flexibility. Any current may be used, from less than 200 amperes to upwards of 1,000 amperes, with a corresponding variation in gas output, thus giving the generator a production range of more than 5 to 1. The normal operating current is stated as 600 amperes, because, generally speaking, at this current the most economical compromise is had between first cost and operating cost. Below 600 amperes the electrical efficiency increases slightly while the production per cell decreases. Above 600 amperes electrical efficiency falls off slightly but the output per cell increases. At 600 amperes the kilowatt-hour efficiency is 3.65 cubic feet of oxygen and 7.3 cubic feet of hydrogen per cell.

The flexibility of the Type 4-1000 generator has this important commercial value: Where current can be had at low cost the plant can be operated at high amperages, giving the requisite gas output from fewer cells; where current cost is high the generators can be run on lower amperage, requiring more cells. In a given plant, at periods of low demand, current can be saved by running at a lower amperage and higher efficiency. Under excess demands the output can be increased from the same battery of cells by using higher amperage at slightly lower efficiency.

The guaranteed purity of the gases from the Type 4-1000 generator is: Oxygen, 99 percent pure or better; hydrogen, 99.5 percent pure or better. Average service results show oxygen 99.6 percent pure and hydrogen 99.8 percent pure. There is absolutely nothing in the construction to wear out or deteriorate either from long use or high temperature; no organic materials whatever are used. The cost of installation, including first cost, freight charges and installation expense, is lower than that of any other oxyhydrogen generator of any type. This, it is claimed, coupled with the exceptional electrical efficiency and flexibility, and the practical elimination of repair and replacement costs, enables the owner of a Type 4-1000 generating plant to secure the maximum volume of purest gases at the minimum total cost and with absolute security against interruption of service except by complete failure of current supply.

The new generator is the product of the International Oxygen Company, 115 Broadway, New York.



Electrolytic Gas Generator Manufactured by International Oxygen Company

Swiss Merchant Marine Planned

Business men in Switzerland are planning for the creation of a Swiss merchant marine to engage in trade with North and South America via the ports of France after the war. A Swiss ocean committee has been appointed, whose object is the improvement of relations by rail and by sea between Switzerland and the Americas by utilizing the French ports of the Atlantic.

Marine Terminals

The city of Seattle, Wash., A. H. Dimock, City Engineer, will soon vote $160,000 in bonds to enlarge the Bell street wharf.

The Board of Harbor Work Commissioners, Newark, N. J., is planning to build a 1,200-foot pier at the Port Newark Terminal, to cost about $450,-000.

Largest Dry Dock in Argentina Completed

According to press dispatches from Buenos Aires, the largest dry dock in Argentina, located at Puerto Militar, near Bahia Blanca, has been completed and successfully tested under the supervision of a board of officers of the Argentine Navy. Actual construction of the dock was begun in the latter part of 1911.

New York Shipbuilding Corporation Insures Employees

The New York Shipbuilding Corporation, Camden ,N. J., has adopted a plan of insurance for all employees, payin the premiums and bearing all expen with funds accruing to the family of the employee in case of death.

Those who have worked at the pl for less than two years have been insured for $500, and for every additional year this amount is increased $100.

Record Year for Delaware Shipyards

Six of the largest shipyards on the Delaware will have launched in the year 1917, 307,604 tons of shipping, representing an approximate value of nearly $77,000,000.

These same shipyards have on their books contracts aggregating 823,081 tons, representing an approximate value of nearly $206,000,000. Fully 70 percent of the 1918 contracts are for the United States Shipping Board.

New Ocean Terminals to Be Built for Emergency Fleet

The Council of National Defense has created an advisory commission on terminal facilities to work with the General Munitions Board and with the special committee of the Board on Storage Facilities. Francis Lee Stewart, consulting engineer, formerly chief engineer of the Baltimore & Ohio Railroad, who represents the ports of Baltimore, will be chairman of the commission.

The committee is making a study of the ocean terminals of the country for the use of war supply vessels, and it is understood that new terminals are to be built especially for the assembling and loading of supplies for American ships abroad and for the allies.

Mechanical Engineers Elect New Head for Coming Year of War Activities

Charles T. Main, of Boston, a consulting engineer who has served in several public offices for the purpose of advancing the idea of good government, has been elected president of The American Society of Mechanical Engi-

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Alexander M. Carlisle, designer of the *Titanic, Britannic* and other famous Trans-Atlantic vessels.

neers, which includes in its membership 8,500 mechanical engineers. Mr. Main was born in Marblehead, Mass., in 1856, and was educated at the Massachusetts Institute of Technology, from which he was graduated in 1876. Since 1892 he has practiced as a consulting engineer, with offices in Boston, until 1907 being associated with F. W. Dean in the firm of Dean & Main.

C. W. Cook Appointed Assistant Director of Shipping for Pacific Coast

C. W. Cook, formerly Pacific Coast manager for the American-Hawaiian Steamship Company, and for many years prominent in San Francisco shipping circles, has been appointed assistant director of shipping operations for the Shipping Board on the Pacific Coast. Mr. Cook will have supervision of the operations of vessels on the Pacific Coast, and will also exercise direction over the progress of shipbuilding for the Emergency Fleet Corporation.

Correction

It was erroneously stated on page 565 of our December issue that the Great Lakes Engineering Works, Detroit, Mich., was erecting a new shipyard at Seattle for the purpose of building vessels of about 9,400 tons deadweight capacity for the Emergency Fleet. While this company's entire programme of shipbuilding now under contract is for ocean service, the vessels will all be built in its three large shipyards on the Great Lakes, all of which are being extensively enlarged. The present contracts which the company now has will average delivery of one ship every two weeks during the year 1918.

Personal

Edwin B. Sadtler, New York agent of the New York Shipbuilding Corporation, Camden, N. J., has resigned to open an office in the Woolworth building, New York City, as a consulting marine engineer and naval architect.

L. F. Hamilton, for the past nine years manager of the advertising and specialty department of the National Tube Company, Pittsburg, Pa., resigned on December 1 to become associated with the Walworth Manufacturing Company, Boston, Mass., as advertising manager.

W. L. Schaeffer has succeeded L. F. Hamilton, in charge of the advertising department of the National Tube Company, Frick building, Pittsburg, Pa.

Edward F. Goltra, president of the Mississippi Valley Iron Company, St. Louis, Mo., has been made a member of the Committee of the Upper Mississippi River Improvement Association, which has been formed to determine a feasible way to rehabilitate the river traffic.

Louis W. Carver, for the past two years purchasing agent for the Chester Shipbuilding Company, Chester, Pa., has become associated with the purchasing board of the United States Shipping Board.

Charles I. Irwin, formerly connected with the American-Hawaiian Steamship Line, has been appointed chief engineer for the San Francisco division of the United States Shipping Board.

J. W. Murray, formerly port captain of the American-Hawaiian Steamship Line at San Francisco, has been appointed port superintendent for the United States Shipping Board at San Francisco.

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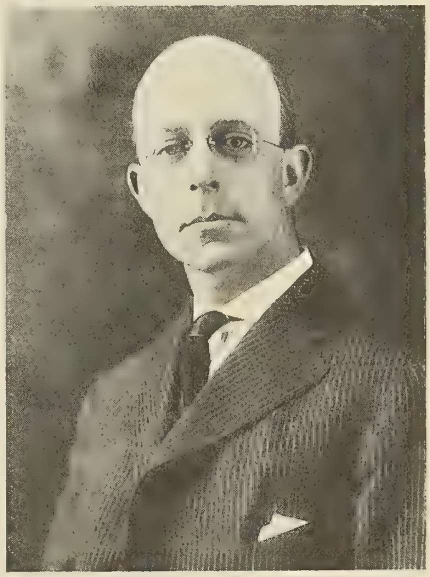
Charles Piez, Vice-President and General Manager Emergency Fleet Corporation

Capt. William Fisher, formerly in command of the Pacific Mail steamship *Korea*, has been appointed inspector of hulls for the United States Steamboat Inspection Service for the district of Washington, with headquarters at Seattle, Wash.

Capt. B. B. Whitney has been appointed Northwest representative of the American Bureau of Shipping.



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Charles R. Page, of California, new member of Shipping Board

The Chester Shipbuilding Company, Ltd., Chester, Pa., announced on December 7 the following members of its organization: Chairman board of directors, W. A. Harriman; president, R. H. M. Robinson; vice-president and comptroller, C. B. Seger; vice-president, C. W. Hamilton; secretary and assistant to president, J. A. Kissick, all of 165 Broadway, New York; treasurer, A. D. Wagner; general manager, W. T. Smith; assistant general manager, E. L. Fries; assistant general manager, L. T. Kniskern; consulting engineer, C. P. M. Jack; engineering manager, Max Willemstyn, all of Finance building, Philadelphia, Pa.; auditor, E. M. Sawyer, Chester, Pa.

Frank W. Hall has been appointed commercial manager of the Sprague Electric Works of General Electric Company. With the exception of a short period Mr. Hall has been connected with the Sprague Works continuously for twenty-two years in various engineering and sales capacities, and for the three years prior to his present appointment occupied the position of sales manager. D. C. Durland, former executive head of the Sprague Electric Works, has resigned to accept the presidency of the Mitchell Motors Company, Inc.

John MacDowell, formerly chief inspector of hull construction for the Standard Transportation Company, of New York, has been appointed by the United States Shipping Board Emergency Fleet Corporation inspector in charge of hulls at the New York Shipbuilding Corporation, Camden, N. J.; the Pennsylvania Shipbuilding Corporation, of Gloucester, N. J., and the New Jersey Shipbuilding Company, Gloucester, N. J., with Charles F. Holden and Otto Ryerson as assistants.

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

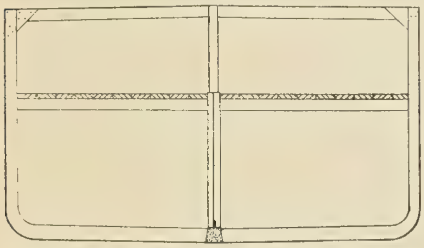
American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,233,237. PROTECTING MEANS FOR SHIPS OR VESSELS. ALBERT C. HOLZAPFEL, OF NEW YORK, N. Y.

Claim 1.—The combination with the hull of a ship or vessel, of a protecting belt secured thereto, comprising a skin, an inner group of substantially hermetically sealed air containing tanks, and an outer filling of soft and light wood arranged between said group and the skin. Three claims.

1,233,380. SHIP CONSTRUCTION. ALEXANDER McDOUGALL AND ALEXANDER MILLER McDOUGALL, OF DULUTH, MINN.

Claim 1.—In a ship's hull of substantially rectangular shape in cross section, a plurality of floor beams spaced apart upon the bottom



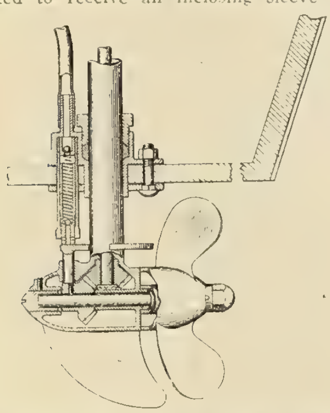
of the hull, a central fore and aft bulkhead fixed to the uppermost edges of the floor beams and a watertight concrete wall between the bulkhead, the bottom and the floor beams. Fifteen claims.

1,213,153. SUBMARINE STEERING APPARATUS. ANDRÉ CITROEN, OF PARIS, FRANCE, ASSIGNOR TO SOCIETE ANONYME DES ENGRENAGES CITROEN, OF PARIS, FRANCE, A CORPORATION OF FRANCE.

Claim 1.—In steering mechanism for ships and the like, the combination with a rudder shaft, of a frame mounted on the shaft, actuating mechanism for said shaft supported by the frame, and means to brace the frame and prevent the same from freely swinging about the axis of said shaft. Five claims.

1,234,370. PROPELLING ATTACHMENT FOR CANOES, ROWBOATS, ETC. CHRISTOPHER J. MEYER, OF WAUWATOSA TOWNSHIP, COUNTY OF MILWAUKEE, WIS., ASSIGNOR TO EVINRUDE MOTOR COMPANY, OF MILWAUKEE, WIS., A CORPORATION OF WISCONSIN.

Claim 1.—A clamping member for boat propeller attachments, provided with a bushing adapted to receive an inclosing sleeve for a



driving shaft, and also having a pump cylinder; said bushing and pump cylinder projecting from said clamping member in position for insertion through contiguous apertures in the hull of a boat. Fifteen claims.

1,209,640. HYDROPLANE-BOAT. CLINTON H. CRANE, OF HEWLETT, N. Y., ASSIGNOR TO J. FREDERICK TAMS AND CHARLES KING, DOING BUSINESS UNDER THE FIRM NAME OF TAMS, LEMOINE & CRANE, OF NEW YORK, N. Y.

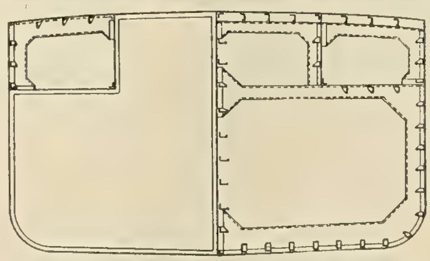
Claim 1.—A hydroplane boat provided with a fixed forward plane member, a wholly submerged after plane member secured to the propeller struts, and riydly set at a predetermined angle in conjunction with the angle of the forward plane member, a second after plane member directly superimposed above, and of larger area than, said submerged plane member secured to the propeller struts and rudder post, and adapted to rise to, or above, the surface of the water as the speed of the boat increases, and a rudder mounted between said after plane members. Four claims.

1,233,381. SEA-GOING CANAL BOAT. ALEXANDER McDOUGALL AND ALEXANDER MILLER McDOUGALL, OF DULUTH, MINN.

Claim 1.—A ship's hull, quadrilateral in cross section from stem to stern, straight sides in the bow thereof, and inclined sides and bottom in the stern thereof. Five claims.

1,234,675. SHIP FOR CARRYING LIQUID CARGOES IN BULK. HUGH LAING AND EDWARD WILKINSON ASHBY, OF SUNDERLAND, ENGLAND.

Claim 1.—A bulkhead construction for a liquid cargo carrying ship of the type known as a "tanker" comprising not less than one longitudinal bulkhead dividing the cargo space into longitudinal compartments, and not less



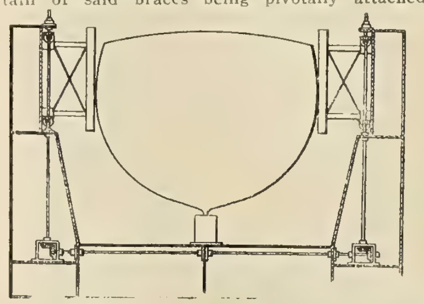
than one transverse bulkhead subdividing said longitudinal compartments, the portions of each transverse bulkhead on each side of a longitudinal bulkhead being out of line the one with the other. Seven claims.

1,216,549. SHIP PROPELLER. MATTHEWS E. DAVIS, OF NEW YORK, N. Y.

Claim 1.—The combination of an iron or steel hull, with a steel propeller shaft having a fixed sleeve insulated from the hull; a propeller shaft having a fixed sleeve insulated from the hull; a propeller keyed to and also clamped endwise in place on the shaft; and a gasket between the opposed walls of the sleeve and propeller hub; the propeller comprising an iron or steel propeller-shaped core and a copper-containing metal coating on its surfaces, and the hull being provided with removable zinc plates adjacent the propeller; the copper-containing metal coating resisting pitting and preventing pitting of the coated propeller core and of the portion of the shaft in the propeller hub bore; and the zinc plates in proximity to the propeller protecting the hull against electrolytic action; and the gasket excluding water from access to the shaft at the joint between the opposed walls of said sleeve and propeller hub; and the said metallic coating increasing the strength of the blades cross-sectionally

1,235,089. MEANS FOR ADJUSTING AND SHORING SHIPS IN DRY SETTING. ANDERS FREDRIK WIKING, OF STOCKHOLM, SWEDEN.

Claim 1.—In a dry dock, vertical shoring beams, braces pivotally attached thereto, certain of said braces being pivotally attached



to the walls of the dock, carriages slidable parallel to the wall of the dock to which the other braces are pivotally attached, and means for sliding said carriages whereby the shoring beams may be moved toward or away from the center of the dock. Three claims.

1,205,766. BOAT-LAUNCHNG DEVICE. ALLEN E. J. LUCKHURST, OF RIDGEWOOD, N. J.

Claim 1.—In a boat launching device, gearing mounted on the davit adapted to rotate the same, means carried by said davit to operate said gearing, and means independent of any operating parts to hold said operating means in fixed relation to the ship. Nine claims.

1,223,154. METHOD OF RENDERING SHIPS UNSINKABLE. WILLIAM T. DONNELLY, OF BROOKLYN, N. Y.

Claim 1.—The method of loading ships, which consists in confining to such an extent only that it will float in water and will afford its between decks watertight container and loading container with cargo portion of the buoyancy required to maintain the ship afloat when water logged. Two claims.

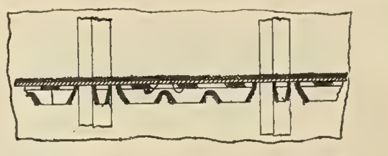
British patents compiled by G. E. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

107,247. "IMPROVEMENTS RELATING TO THE WATER-TIGHT DOORS OF MOTOR-DRIVEN VESSELS." E. RINGSTED, 52, RANDOLPH GARDENS, BROOMHILL, GLASGOW, AND BARCLAY, CURLE & COMPANY, LTD., WHITEINCH, GLASGOW.

This invention relates to an improved mode of operating the water-tight doors of motor-driven vessels having engines of the Diesel or like type. Under this invention, compressed air is led by a pipe connection from the compressed air pump of the Diesel or like motor engine through an automatic reducing valve to a compressed air reservoir, from which again air pipes pass to the various watertight doors of the ship. Valves are provided in connection with these pipes so as to control the air supply to the operating mechanisms of the doors, these valves being operable from the bridge or other suitable part of the ship in any well-known and suitable manner.

108,189. IMPROVEMENTS RELATING TO SHIPS' DECK STRUCTURES, BULKHEAD STRUCTURES, AND THE LIKE. THE QUASI-ARC COMPANY, LIMITED, MANUFACTURERS, AND W. L. COLE, ENGINEER, BOTH OF CAXTON HOUSE, WESTMINSTER, LONDON.

For inserting and securing in place in a watertight manner the decks, bulkheads and the like of a ship, brackets are welded to the ship's plating at a level to support the deck or



the like, and any re-entrant spaces in the ship's frame members are filled in with insertions welded into place at the deck level, after which the deck when inserted is secured and rendered watertight by a fillet of welding metal deposited around the whole of its edge against the ship's plating and against the frame members and filling insertions therein.

107,779. IMPROVEMENTS IN REVERSIBLE BOATS. T. H. GASKIN, OF WELLINGTON VILLA, GROVE ROAD, WOODFORD, ESSEX, BUILDER.

This invention relates to reversible boats or rafts adapted for being carried on shipboard and capable of being used in place of the ordinary non-reversible lifeboats with which ocean-going vessels are as a rule provided. The reversible boat has two separate decks, each of which occupies the entire area of the corresponding well of the boat; both the peripheral buoyancy chamber and also the supplementary buoyancy chamber constituted by the space between the decks, serving to accommodate a series of hermetically sealed air tanks, which are independent of the structure of the boat.

103,860/16. "METHOD OF AND APPARATUS FOR MINIMIZING THE DAMAGE TO A SHIP WHEN WATER ENTERS ANY COMPARTMENT." A. J. F. LEE, OF 204, GIROUARD AVENUE, NOTRE DAME DE GRACE, MONTREAL, CANADA, COMPRESSED AIR SALVAGE BROKER.

In specification No. 281, of 1915, means are described by which, in vessels provided with a supply of air under pressure, and in which the separate compartments of the hold are constructed so as to be individually air tight, in case of any damage to the hull causing an inflow of water to any compartments, the valves controlling the admission of air to such compartments are opened, either manually or automatically, and air is admitted, which acts as a cushion to hold back the water or to force it down to the highest point of the break and thus keep the vessel afloat until repairs can be effected. According to the present invention, means are provided for maintaining, when the hatches are closed, a constant flow of air through the compartments, such means comprising pipes opening into the lower parts of the under-water compartments and communicating with the exterior, and means for controlling the flow of air through the said pipes.

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Shipbuilders Must Redouble Their Efforts

TO shipbuilders the entire nation will look during the coming months for unprecedented activity. Former records of production will no longer be acceptable. The seemingly impossible must be achieved, and that quickly. The diminished rate of shipping losses, encouraging as it is, in no way lessens the demand for more ships. Every ton of shipping that can be produced must be launched in the shortest possible time.

Less than a million tons of merchant shipping was produced in the United States last year, but, in the meantime, the foundations have been laid for a vastly increased output. No less than 700 shipways are now available, as against 148 last April, and more are rapidly nearing completion. According to official figures published in December the wooden ship programme is 9 percent complete; the requisitioned steel ship programme, 39 percent complete; the composite ship programme, 20 percent complete, and the contract steel ship programme, 4 percent complete. This much has been accomplished before the new shipyards have really begun to build ships and during a period when the older yards were largely engaged in naval work, and, furthermore, were seriously handicapped by labor and housing troubles.

Most of these preliminary difficulties are now being taken in hand, means are apparently in sight for relieving the most serious phases of the situation, and the new yards are squaring away for uninterrupted intensive production. It now remains for the shipbuilders to redouble their efforts and prove to the country that the responsibilities intrusted to them will be fully met.

Operation of the New Shipyards

TWO, at least, of the new Government fabricated steel shipbuilding plants will shortly be in operation. Successful shipyard operation, however, depends primarily upon the two factors of management and labor. In accordance with plans already perfected sufficient labor will in all probability be available for these yards, but it will consist mainly of men who have had little or no experience in shipbuilding and who must be trained. Under these conditions the real responsibility will lie in the hands of the executive organizations of the yards. Competent shipbuilders can be obtained only from other yards. More difficult still, however, is it to secure men with executive ability, combined with shipbuilding experience, who are accustomed to handling contracts running into the hundreds of millions to be executed within the short space of a few months. It is for this reason that we call attention to the suggestions made in an article published elsewhere in this issue in which a plan is outlined for utilizing as sub-contractors in the new yards the executive organizations and working forces available in kindred industries. This plan has the merit that such organizations have well defined working policies fully capable of producing results in steel construction work. The men are accustomed to working together and successfully carrying out large contracts in limited time. With proper supervision by expert shipbuilders such a method of co-ordinating working organizations as subcontractor units for the actual erection and completion of the ships at least is worthy of careful consideration, especially as it is a plan commonly used in large building enterprises, a conspicuous example of which is the construction of the Bristol shipyard itself.

Getting the Men to Build the Ships

WITH the combined aid of the Council of National Defense, the Shipping Board, Governors of States, and organized labor and business, the Department of Labor began on January 28 the recruiting of an army of 250,000 men to fill all present and future needs of the shipbuilding yards of the United States. Men skilled in any of the mechanical trades used in shipbuilding, and willing to accept employment in this branch of war industry, are being enrolled and registered in the United States Public Service Reserve, a division of the United States Employment Service. With the institution of this coast-to-coast drive for shipbuilders, the independent efforts of the Shipping Board, Council of National Defense and the individual shipyards cease, and the entire shipyard labor supply question is turned over to the United States Employment Service of the Department of Labor. Men fitted for shipbuilding work and shipyards in need of men will hereafter be brought together through the medium of the Federal Employment Service, which, with the co-operation of State and Municipal Employment Services, now has more than two hundred labor exchanges throughout the United States.

During a two-weeks' period, beginning January 28, thousands of "four-minute men" will explain to audiences all over the country what shipbuilding means to America in this war. They will tell of the requirements of the yards and encourage enrollment in the Public Service Reserve. Every part of the United States will be covered in this educational campaign, which will culminate on February 11 with a National Shipbuilders' Registration week, during which all the volunteers for shipbuilding will be registered as to their experiences, skill and trade by exports of the United States Employment Service.

Since the United States entered the war, millions of Americans have been waiting to be told what service they can best render. Trained riveters, boiler makers, machinists, blacksmiths, carpenters, calkers, millwrights and

other experienced mechanics can render no service more evidently needed than the service of the nation in the shipyards. Every skilled workman who volunteers for work in the shipyards may well feel that he has joined the military forces of America. Every rivet driven is a blow at the Kaiser; every ship turned out brings nearer the day of democracy's triumph. The Government counts confidently upon the patriotism of the skilled workmen themselves, but employers can be most helpful in facilitating the releasing from non-essential industries of the skilled workmen who desire to volunteer for the shipbuilding reserve.

Every man registered in the Public Service Reserve will not be immediately required, and the Department of Labor urges all workers to stick to their present posts until they are needed. It should be understood that there is no general labor shortage at the present time, but that the problem is purely one of distribution of labor where and when it is needed. Independent efforts in the past to obtain shipyard labor frequently resulted in premature and unnecessary removal of workers from the so-called non-essential industries and the unintentional taking away of men by one shipyard from another. Hereafter every shipyard in the United States in need of men will notify the United States Employment Service of its requirements and these will be filled without delay from the lists of unemployed and from the members of the Public Service Reserve. By knowing in full the number and ability of the men in the country fitted for and willing to work in shipyards as well as the immediate and future labor needs of the shipyards, the Employment Service will be able to meet every shipbuilding labor requirement as long as the war lasts.

Housing of Shipyard Workmen

ADEQUATE housing of shipyard workmen is absolutely essential before further expansion of shipbuilding facilities can take place. At practically every large shipbuilding center in the United States lack of housing facilities has been the principal cause of delay in the Government shipbuilding programme. More men are continually needed, but they cannot be obtained unless provision is made for their housing near the shipyards. This problem is further complicated by the fact that some of the larger shipbuilding centers have been chosen as the sites of military bases and army camps, thus further increasing the population in these communities and lessening the available housing facilities. Coupled with the housing problem there is also the question of transporting the workmen from their homes to the shipyards, in many cases the transportation facilities proving wholly inadequate. Committees from both the Shipping Board and the War Industries Board have thoroughly investigated these conditions and appropriations have been asked from Congress to carry out their recommendations. In no other way can the problem be solved and immediate action must be taken to relieve the situation.

New Set of Bunker Regulations

BECAUSE of the largely increasing number of vessels of all nationalities that have to get bunker licenses before they can clear from American ports, a new set of bunker regulations and rules has been announced by the War Trade Board, which becomes effective on February 1. No vessel is allowed to clear from any port of the United States or its possessions without having secured a license or licenses covering all bunker fuel, port, sea and ship's stores and supplies aboard the vessel at the time of sailing. The license or licenses must cover not only the fuel consumption and supplies taken aboard at the port of the United States, but also the fuel, stores and supplies which the vessel brought into the country when she entered.

The War Trade Board is desirous of doing everything possible to avoid the detention of vessels, but it is emphasized that voyages and charters for all neutral vessels, and all American vessels not requisitioned by the United States Shipping Board, should first be approved by the Charter Committee of the United States Shipping Board of New York. This committee will then inform the War Trade Board of the approvals they have given, so that the War Trade Board will have this information at hand when considering each application for license.

If these directions are carefully followed, delays will be avoided in granting licenses. The rules have been sent to vessel owners and other interested parties and may be secured upon application to the War Trade Board, Bureau of Transportation, Washington, D. C.

Important Step of North-East Coast Institution

THE important departure of the North-East Coast Institution of Engineers and Shipbuilders, in appointing a committee of expert engineers to test apparatus offered by manufacturers and accepted by the Council, has resulted in a very comprehensive report on the working of air pumps, such as are used in connection with the condenser plants of steam engines. The manufacturers in this case were Messrs. Richardsons, Westgarth & Company, Ltd., and the tests were carried out at their Hartlepool Works. The report, presenting as it does authoritative and reliable data, should prove of great value to engineers, especially with reference to the production of high vacuum for steam turbines and the more economical production of low vacuum for cargo vessels. Furthermore, it definitely marks the opening up by a scientific institution of a new and more valuable field of activity, and there can be little doubt that the example which the North-East Coast Institution has set will be followed elsewhere, so that ultimately organized scientific research in engineering and other branches of industry will become more active and general instead of passive and exceptional. When this much-to-be-desired ideal is reached, there will obviously be a speeding up in the recognition and adoption by manufacturers of improvements and an increasingly accelerated rate of progress in the industries concerned.

Life Saving Equipment for the Emergency Fleet

WHEN it comes to safeguarding or saving lives at sea, the best equipment is none too good. Actual life saving should be the prime consideration when it comes to the equipment of the vessels now building for the Emergency Fleet. Many of these vessels will be used as army transports and the cargo vessels will be manned not only by the ordinary crews for the navigation of the ships, but also by gun crews for the protection of the vessel. In any case, the men on board the vessels, subject to the danger of travel in the war zone, are the officers and seamen who have been trained to serve their country and the preservation and protection of their lives become of first importance. It should be remembered that the safety of all on board does not depend on the life-

boats alone, but also on the chocking and stowing of the lifeboats, on the reliability of the davits and releasing gears, and, in fact, on the merits and efficiency of even the smallest detail of the equipment. Even seconds count when it comes to releasing lifeboats and getting them overboard safely in time of danger.

Two years ago a new law was passed requiring all passenger ships under the American flag to be equipped with at least one power lifeboat. Under present conditions, the application of this rule to cargo ships would be a step in the right direction. One power lifeboat on each of the cargo ships now being built for the Emergency Fleet would provide safety for the entire ship and gun crews. A 28-foot motor boat, for example, with a capacity of forty to fifty persons, and, in emergencies, capable of taking care of double that number, provided with a reliable heavy duty engine and a fuel capacity of 150 gallons would have a cruising radius of about 300 miles at an approximate speed of 6 to 7 miles per hour. Such boats would be more expensive than the regular lifeboat equipment, but the increased cost, in our opinion, would be a negligible item as compared with the greater safety provided for the thousands of men who are volunteering for this hazardous service.

Combined Steel and Concrete Ship

THERE is now being developed under the name of the Hunnewell hull a new type of ship's hull, consisting of a steel or wood middle body and concrete ends, especially designed for the rapid and economical building of sea-going cargo vessels. This new style of hull, for which patents have been applied, is the invention of Constructor F. A. Hunnewell, U. S. Coast Guard, and is receiving attention from both naval constructors and private ship owners and designers.

Concrete as a material for shipbuilding is being widely exploited at the present time, chiefly in the form of complete reinforced concrete hulls for vessels. Progress in this direction, however, has been limited to vessels of small size and the optimistic claims of many of the reinforced concrete ship advocates remain to be substantiated in actual test. The proposal, therefore, to build vessels of steel or wood with concrete ends is an entirely new departure and one which takes full advantage of the two systems of construction.

The parallel middle body may be a simple fabricated steel structure designed to carry the loads of the machinery installation and the stresses on the hull in a seaway. The shaped ends, on the other hand, which are the more expensive parts of the steel hull to construct, are of reinforced concrete, so designed as to withstand under all conditions the water pressures and the local shocks and loads. This use of steel and concrete is justified, it is claimed, as a consistent and economical design, while the utilization simultaneously of the two distinct kinds of material and labor should result in more rapid construction than the conventional types of hull permit.

In such a design, it is obvious that from a constructional point of view the greatest possible length of parallel middle body will be advantageous. It is understood that experiments are being made in the model towing tank in Washington to determine the most satisfactory proportions of a parallel middle body in cargo ships at various speeds. Another interesting problem involved is the method of joining the reinforced concrete ends to the steel or wood hull. Several solutions to this problem are being investigated and no difficulty is anticipated working out this novel detail of ship construction.

LETTERS TO THE EDITOR

"The Return to the Reciprocating Engine"

You are right in your contention that a return to reciprocating machinery, particularly for auxiliaries in marine power plants, would be a step backwards. We send you herewith drawings and photographs which illustrate the saving in space and the gain in simplicity, and therefore reliability, obtainable with turbine-driven auxiliaries.

The reason that reciprocating engines have been used so extensively for the Emergency Fleet is that many shops are already equipped to build engines, while few concerns have the facilities and experience necessary for the production of the high-grade gears required for turbines for propulsion. The same consideration does not, however, apply to so great an extent in the case of auxiliaries.

Besides their simplicity, small size and less weight, turbine auxiliaries are more efficient. Although auxiliary exhaust can be applied to heating feed water, there is generally a surplus, which is either bled directly to the condenser, with an entire loss of its contained heat, or to the intermediate receiver and used with low efficiency in the low pressure cylinder. Is it not self-evident that the steam, which is expanded to about atmospheric pressure for feed heating, should in the expanding process contribute as much power as possible; that is, that the auxiliaries should have the highest attainable efficiency?

Turbine-driven units maintain their initial efficiency almost indefinitely, since they are not affected by leakage of valves or piston rings, and any wear of turbine buckets which may come about after long use is quickly and inexpensively remedied by the insertion of new buckets. The same applies to pump parts.

Turbine-driven auxiliaries are most flexible as regards conditions of operation. They will operate on steam at any practicable superheat or at any pressure without injury. Likewise, turbine-driven centrifugal units are self-regulating, no harm or trouble being experienced if the discharge is suddenly cut off or opened wide, and the piping system is free from vibrations, pulsations or water hammer.

The elimination of sliding surfaces and of numerous valves and packings diminishes the attention and labor required. Also, the fact that in modern turbine manufacture all parts are made interchangeable on a limit-gage basis renders the insertion of renewals or repairs a simple matter, which is further facilitated by their light weight and small size.

About the only supply required for turbine-driven auxiliaries is bearing oil, in amount about equivalent to that used by an electric motor. No oil or grease is introduced into the auxiliary exhaust, simplifying the task of keeping oil out of the boilers.

As to the matter of reliability, Mr. Heward, who writes in your December issue, should turn to page 545 of the same number and read the paragraphs by Captain Dyson beginning "One of the great sources of failure to hold high speed in vessels had been the continually recurring breakdowns of forced-draft blowers with engines of the reciprocating type," and, after describing one make of turbine blower unit tried, concluding, "This error was corrected and the fans, by their later performances, instilled such confidence that no other type of blower than that of the turbine-driven has since been considered for destroyer work, and in later vessels of other types it has even

shouldered the electric-driven fan out of the way, as the flexibility of control is so much greater."

Referring to the illustrations, Fig. 1 shows a 10-kilowatt, direct-current generating set as used for auxiliary lighting purposes. A velocity-stage turbine drives a directly connected generator at 3,600 revolutions per minute.

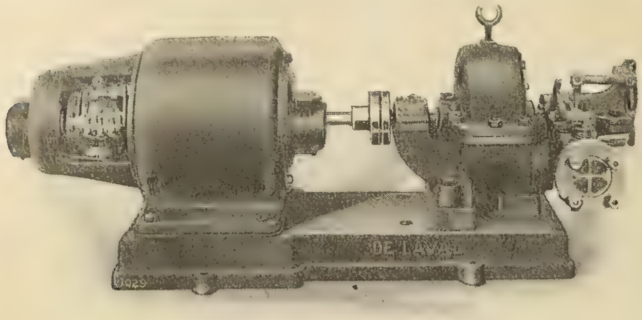

Fig. 1.—Small Auxiliary Lighting Set. Consisting of Direct-Current Generator Driven by Velocity-Stage Turbine; 10 Kilowatts, 3,600 Revolutions per Minute.

Fig. 2 shows a turbine-driven geared circulating unit having a capacity of 5,500 gallons of water per minute against a total head of 27 feet. The turbine is of the simplest type, having two rows of impulse buckets mounted on a single wheel or disk. The speed-reducing gear makes possible the use of a high-speed turbine and a slow-speed, large-diameter pump, as required for efficiency for large capacities and low heads. All working parts—that is, the turbine wheel, the gears and the centrifugal pump impeller—are at once accessible upon lifting the casing covers and without disturbing piping or bearings. The total space occupied is only 95 cubic feet, and the weight approximately 4,800 pounds.

Fig. 3 shows a combined turbine-driven boiler feed pump for 3,000 boiler horsepower capacity, the whole occupying a space of only 23 cubic feet and weighing 1,200 pounds. In this unit the turbine rotor and pump impeller are mounted upon one shaft and contained in one casing. The suction end of the pump is adjacent the turbine exhaust, metallic packing being used. As the pressures are very low, any leakage of water or steam is immaterial. The packing at the discharge end of the pump also is subjected to suction pressure only, due to the use of a hydraulic balancing system, while the packing at the inlet end of the turbine is subjected to exhaust pressure, the turbine being of the impulse type with a single pressure stage. There are only two bearings and one valve, viz., pressure governor valve. Comparison is invited between the space occupied by this unit and that required for reciprocating boiler feeders.

Trenton, N. J. Geo. B. Gibson,
The De Laval Steam Turbine Company.

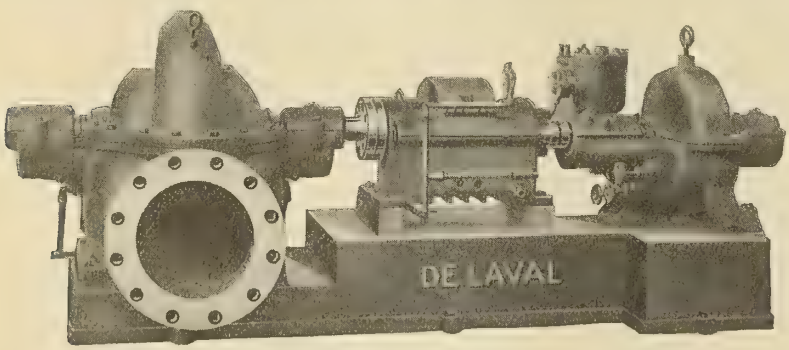

Fig. 2.—De Laval Geared Turbine-Driven Centrifugal Condenser Circulating Pump

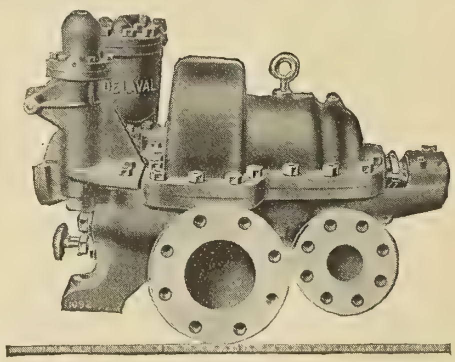

Fig. 3.—De Laval Turbine-Driven Boiler Feed Pump; Capacity, 3,000 Horsepower

S. S. Freeman

The thirteenth vessel launched by the New York Shipbuilding Corporation, Camden, N. J., in 1917 was the S. S. *Freeman*, a single-screw steel collier, with machinery located aft, originally contracted for by the Pocahontas Transportation Company. The keel was laid in June and the vessel was about 85 percent complete at the time of launching on December 27.

The *Freeman* is 332 feet 6 inches long over all; 319 feet long on the waterline, with a molded beam of 49 feet 3 inches and a molded depth of 27 feet 6 inches. She has a single deck with poop, bridge and forecastle. A double bottom extends all fore and aft, and peak tanks are provided for water ballast. There are steel deckhouses on the poop and bridge and a wooden pilot house on the bridge deck house. The crew is berthed aft alongside the engine casing on the main deck.

The cargo space is divided into four holds. Steel cargo hatches are built to form a continuous girder along each side. The forward end of the poop is arranged for a coal bunker with hatches on the poop deck with coal trunks leading to the forward end of the boiler room. A plate bulwark is fitted between the poop and bridge and between the bridge and forecastle. The capacity of the four cargo holds, including the trunks, measured to the top of the tank, is 230,000 cubic feet.

Two tanks for drinking water, of 2,700 gallons' capacity each, are located in the after engine room. The reserve feed tanks are in the double bottom under the boiler room.

The vessel will carry 4,900 tons total deadweight on a draft of 20 feet 8 inches, or 5,450 tons on a draft of 22 feet 8 inches. She is designed for a sea speed of 10½ knots under ordinary conditions.

There are eight main hatch openings, each 15 feet by 28 feet, with patent steel hatch covers. For raising the hatch covers, there are eight built-up plate and channel king-posts securely bracketed to the trunk top and fitted with arrangements for securing the covers when open. Two pole masts are fitted, stepping on the trunk and equipped with crows' nests. A spruce boom, 12 inches by 40 feet, is fitted on the foremast capable of lifting a 2½-ton working load.

The propelling machinery consists of a vertical, direct-acting, triple-expansion, surface-condensing engine with cylinders 21 inches, 35 inches and 58 inches diameter by 42 inches stroke, supplied with steam at 200 pounds per square inch working pressure by two single-ended Scotch boilers, 14 feet 3 inches inside diameter and 11 feet 5/16-inch length between heads arranged to fire fore and aft with the fire room forward. The main condenser is cylindrical in shape and contains about 2,720 square feet of tube cooling surface. The shell is built of steel plate and the heads of cast iron.

Who Will Build the Fabricated Ships?

Organized Working Forces from Kindred Industrial Plants Suggested Remedy for Shortage of Skilled Shipbuilders

BY ROBERT E. KLINE *

ABOUT six months ago American shipbuilders were called in conference at Washington by the Shipping Board to devise means whereby during the succeeding year the output of ship tonnage then under contract could be at least doubled. Such a task, said the shipbuilders, is a physical impossibility. As their reasons, they cited the lack of sufficient shipyard labor and the lack of facilities in the country for turning out the additional raw and manufactured materials requisite for the work.

In view of the dire necessity for more ships, however, the Shipping Board Emergency Fleet Corporation "took the bit in their teeth" and, although against the judgment of experienced shipbuilders, launched a programme entirely new in the annals of the shipbuilding industry. That the Shipping Board did launch this unprecedented programme, against the counsels and advice of those most skilled in the shipbuilding industry, shows their indomitable purpose to succeed and to secure results when necessity demands. There was no time for temporizing, nor was there any intention of crippling existing shipbuilding industries by encroachment or competition or working to their detriment. On the contrary, it was the purpose of the Shipping Board to afford at the same time to the existing agencies in ship production all necessary co-operation and support; in fact, more than heretofore. It was just as essential to secure as large an increase in the output of these concerns at the same time as the additional output from the proposed new yards.

New Government Shipyards Projected

It was the plan of the Shipping Board to harness up, as new factors in the production of shipping, certain industries kindred to shipbuilding and artisans skilled in similar work. Three new shipyards were to be established, one at Philadelphia, one at Newark and one at Bristol, in which standardized vessels were to be built from parts fabricated in the structural shops throughout the country. The act of creating new assembling yards for the standardized building of fabricated ships is now being paralleled in practically all the lines of war industry, and is, therefore, presumably a logical expedient to the end. From my personal experience thus far as U. S. plant engineer in charge of the work at the Bristol government yard from its inception, I am fully convinced by reason of the results already attained that the programme can be carried out, and that, too, practically within the time set down, both as regards the construction of the new plants as well as in the construction of the ships.

Government Plans Arouse Criticism

There has been much criticism, some of it more or less just, that the measures adopted in plant construction thus far have been extravagant. As measured against the imperative necessity of building these yards, and thereafter the quota of ships, within the stipulated time, there is no time to haggle over these necessary expenditures if the funds are honestly applied. In view of the great crisis which the nation is facing, the amounts expended for this work become insignificant; besides, the money is being spent at home.

The contention is made, however, and justly, that the old shipyards, endeavoring in the same spirit to meet the war emergency needs, are tied to unprofitable contracts and are thereby unable to compete with the Government now launching this new enterprise. This phase of the subject is worthy of attention, but the Shipping Board is endeavoring to meet this situation by certain allowances. In any case where the necessary adjustments have not been made, upon proper determination of this fact such matters will undoubtedly be adjusted upon a basis entirely satisfactory to all, so that such ship production will not be impeded, but, on the contrary, will be accelerated.

Men Drawn From Established Yards

The main cause of this outcry from the old shipyards, however, is the fact that much of the labor, both skilled and unskilled, hitherto employed in the older yards is being attracted to the new yards by increased wages and other inducements. It is to offer a solution, if possible, of this phase of the matter that this article is written.

At this particular time, when the three great Government shipyards are about ready to assemble their forces for ship construction, the question of who will build these fabricated ships is of paramount importance. It is obvious that in any plan involving the establishment of new shipyards, help must not be drained from the old shipyards, nor must the personal interests of the older shipbuilders be violated. How, then, shall the problem be solved?

A Way Out of the Difficulty

In my opinion, the most logical and practical plan is for the three shipbuilding corporations (acting as agents for the Emergency Fleet Corporation in operating the new Government plants) to secure as sub-contractors for the actual erection and completion of the ships in the yards working organizations, including the executive working staffs from the industrial plants of the country that are best fitted by previous experience in similar work for carrying out the various processes in shipbuilding. There are hundreds of industries in our country, particularly in the Middle West, which are now idle, due to lack of working materials because of war demands. Under normal conditions in the past these industries have been engaged in work kindred to that of shipbuilding, and they can not only provide complete overhead organizations with defined and successful working policies, but they can also furnish the complement of labor forces for these new yards without encroachment on the old yards, if they are called into this service. Furthermore, their adoption will no doubt suggest the means to provide additional and necessary help where the need of same is felt in yards now operating.

In making this suggestion, I lay no claim to its originality, as it may already have been discussed and determined upon or rejected in councils higher up. In fact, it is but a suggestion to use the plan usually pursued in large

* Plant Engineer, United States Shipping Board Emergency Fleet Corporation, Bristol, Pa.

building enterprises—that of co-ordinating forces from various crafts on one contract, yet under distinct organizations. It is the plan which has so successfully been followed in the building of the Bristol Government shipyard. Here in a short period of four months the plans for the yard have all been evolved, and the plant, providing a shipyard and shops adequate for the assigned task of building sixty 9,000-ton ships within a period of eighteen months from this date, has practically been completed. Considering the time involved and the enormity of the task, its completion in so short a time is a remarkable achievement.

This success, however, is attributable not only to the excellent capability, foresight and determination on the part of the management of the Merchant Shipbuilding Corporation, agents for the Government on this contract, but by reason of the fact that they collected together working organizations as sub-contractor units to carry out such portions of the construction as they were particularly fitted by their experience to undertake. In other words, it is the same plan that I am suggesting as a possible solution of the problem as to who will build the fabricated ships.

How the Plan Worked in Building the Bristol Plant

Taking the case of the construction of the Bristol yard by the Merchant Shipbuilding Corporation as an example, the various contractors engaged in this gigantic task, and who, by their co-operation under the leadership of the main organization of the company, have brought the work to a successful conclusion, included the following: For building shipways, craneways' foundations, including outboard piling, John Monks & Sons, New York; housing and ship buildings, Fred T. Ley, Inc., Springfield, Mass.: installation of power plant equipment, machinery, pipe lines, electrical and mechanical equipment, William Gordon Corporation, Philadelphia and New York; concrete piling, Raymond Concrete Pile Company; furnishing and erection of structural steel on buildings, Leverring & Garrigues; dredging, American Dredging Company, Philadelphia; construction of pier and bulkhead, George E. Cantrell, Inc.; power house stacks and other labor work, Alphons Custodis Company.

Such elements of construction as were not disposed of by sub-contractors were handled by the organization of the Merchant Shipbuilding Corporation, headed by W. H. Mason, superintendent of construction. Mr. Mason was the master head of the composite unit, embracing the several sub-contract forces referred to as well. In this case, therefore, co-operation between various sub-contractors as led by the main organization of the company and by those in charge for the Government was the keynote of success. The fact that this method can be applied so successfully in plant construction leads to the presumption that a similar process of procedure will likewise be successful if applied to ship construction.

Organized Industries and Men are Available

Many concerns with their entire complement of organizations, in the Middle West particularly, are now idle through inability to secure raw materials. It is, therefore, urged to make use of such organizations, particularly as it is important to have not only sufficient skilled and common labor for ship work, but also to have perfect working executive organizations for carrying out the work. This, in my belief, can best be obtained by resorting to sub-contract methods. Without such experienced organizations in charge of the work, the mere herding of labor on these shipbuilding contracts, even if available in greater numbers than needed, and even though many of them have attended the shipbuilding training schools now in vogue, would result in muddle and great financial loss in actual ship construction, besides the loss of valuable time.

The pessimist who has criticised this new plan of shipbuilding has said that there would probably be no doubt of successful attainment in the construction of plants and yards, because this is in the usual line of construction, but that the same success could not be expected when ship construction is involved.

The practical shipbuilders, including many of our own government ship experts now retained, decry my suggestion as being impracticable. They say that men heretofore engaged in allied crafts make poor shipbuilders, that this has been proved by precedent and where tried in a few instances in the past had to be given up.

Perhaps so, but, in this new case, where new men must be had and the assembling of standard parts will constitute the routine of shipbuilding, this objectionable phase in work of allied crafts, if existent at first, will be quickly eliminated and their early inaptitude under the watchful eye of these few ship experts now retained will result in but little damage and delay, if any at all, and this will pertain only to the first short interval of work. They will soon be proficient.

Conclusions

In conclusion, I see no reason why such allied factors, collectively efficient as cited, should not be contracted with or otherwise obtained as working units to perform their respective portions of this enormous task and to assure the scheduled completion thereof without interference with other shipyards. Whatever is done, however, must be done *at once*. Men interested in shipbuilding heretofore should combine their best efforts in aiding the Shipping Board in carrying out its shipbuilding programme. The new shipyards are in business to stay and to help win the war, and must be fostered to that end, not opposed. Who better than these experienced heads are able to perform this great service?

Differences have existed at times in the Shipping Board as to methods, but none as to the objects to be attained. All are equally imbued with the same patriotic loyalty to our nation's welfare and with the same desire to make available quickly the much-needed tonnage.

The available ship experts must be driven to "pep" new to their experience by master administrators, as upon the latter will fall the new real responsibility for getting out the necessarily speeded output of ships, all of which must be completed with intensive expedition to supply the demand as well as to restore normal economic conditions generally.

Annual Motor Boat Show

"What the motor boat industry is doing to help win the war" was the keynote of the fourteenth annual National Motor Boat Show, held in the Grand Central Palace, New York City, January 19 to January 26. Although many exhibitions are being omitted this year on account of war time conditions, the fact that practically the entire motor boat industry is engaged in manufacturing hulls, motors and equipment of various sorts for the government, to say nothing of submarine chasers and other naval vessels, has been a sufficient reason for the leading concerns in this important industry to make extensive display of their products at this show. The display was not only educational, but patriotic and inspiring as well.

Co-ordinated Transportation Between Railways, Ocean and Rivers*

Comprehensive Plan for Developing the Inland Waterways of the United States—Waterways Commission Proposed

BY HON. FRANCIS G. NEWLANDS†

IN order to have a thorough-going system of transportation, both for the prosecution of the war and for the commercial contest which is to follow the war, we need a system of co-ordinated transportation between the railways, the ocean and the rivers of the country.

Neglected Merchant Marine

For years we have neglected our merchant marine. We have done so because of radical differences of view between the two great parties of the country as to the policy which should be pursued. The war came and forced upon us an immediate solution of this question.

The only adequate solution, which was entered upon reluctantly by many, was to cut the Gordian knot and turn over to the Government itself the task of creating and owning a large merchant marine. That work is now progressing, and we will find a merchant marine created not only to meet the requirements of the war, but the commerce of the country after the war. The only unattended-to link in transportation thus far has been that of river transportation.

We have in this country the greatest rivers in the world. In no country on earth would it be possible to create such a splendid system of waterway transportation as we might have in the United States. Yet we have addressed ourselves to this question in the most superficial manner. We have allowed the "spoils system" to prevail, the system of individual initiative by a Congressman or a Senator in a particular district or a particular State, in the shape of a bill urging a local development. We have never had a comprehensive study of all our rivers from source to mouth, with all their tributaries, a careful survey of the engineering possibilities, a careful estimate of the cost. We have never yet proceeded under broad and comprehensive plans to enter upon the great constructive work of river development, the work of making our rivers as effective instruments of transportation as the rails, with not only a track, in the shape of a perfect channel, but with a bank protection so created as to avoid destructive overflows; with transfer facilities and terminal facilities enabling them not only to compete with the railways, but to co-ordinate with the railways wherever necessary.

Half a Billion Spent Under Spoils System

And we have spent five hundred or six hundred millions of dollars under the system of individual initiative, popularly known as the "spoils system," without appreciable headway in the development of river transportation.

Compare the economic development of Germany, France and Austria, and even Russia, with this, and you will find in each of the first three countries named there is a perfect system of co-ordinated transportation between the rivers themselves by connecting them at their sources, wherever necessary, with artificial channels. Thus you have not only perfected channels, perfected banks, perfected transfer facilities, perfected terminals, but also rivers so connected with each other by artificial channels that you can go from any part in France or Germany to any other part as well by river as you can by rail. The two systems are so co-ordinated with each other and with the ocean system, under governmental authority, as to produce a perfected system of rail, river and ocean transportation.

To-day, in the very throes of war, Austria and Germany are building a channel between the head waters of the Rhine and the head waters of the Danube, with a view of developing the commercial facilities of those countries after the war. This will result in an enterprise which will give one system of inland waterway all the way from the North Sea down to the Black Sea, into which the Danube enters. Then these two great rivers—the Rhine and the Danube—will be connected with almost all of the other rivers of these two countries in such a way as to make as complete a system of waterway transportation as they have of railway transportation.

Causes for Neglect

When we think how we have neglected our rivers, we inquire as to the cause. One cause has been the desire of the individual Congressman or Senator to maintain his power regarding appropriations, be able to go back to his district or State and hold up as the evidence of his usefulness a bill on an appropriation calling for the development of a project within his district. Another reason has been that the railroads themselves, in this great period of war expansion, building their railroads out as pioneers into communities where there was little or no population, and dependent for future prosperity upon building up a transportation business, have regarded with great jealousy any existing system of river transportation that competed with them.

So we had there quite persistent interest raising false issues as to economy here, raising conditions of confusion there, and through many disturbing influences, preventing us from entering upon any conceived scheme of river legislation. The result has been that the very imperfect system of river transportation that once prevailed has been destroyed because we have permitted the rail carriers to club the river carriers out of existence. We have enabled them to sandbag their competitors, or have permitted them to do so.

Comprehensive Waterway System to Benefit All

However, I am glad to say that after ten years or more of constant agitation with reference to a bill which I had the honor to introduce, and which is well known by the chambers of commerce and waterway associations of the entire country, the provisions of that bill, in a modified form, with the aid of this Administration, were inserted in the last Rivers and Harbors Bill. We have there complete authority to the President to organize a waterways commission, which will bring into co-ordination the ten or twelve engineering services of the country now engaged in

* From an address before the Editorial Conference of Business Papers, Washington, D. C., December 13, 1917.
† Senator from Nevada and chairman Joint Congressional Committee on Interstate Commerce.

a detached way, not in a co-ordinating or co-operative way, upon some problem of the water question, to bring them into co-ordination through a commission. Also authorizing this commission to secure the co-operation of the States with the Nation in great works involving the jurisdiction of all the sovereignties, so that the Nation and the States, by a system of team-work, can proceed with the great work of developing these rivers not only for navigation, but for the use of the flood waters in irrigation; also for use in the creation of water power, for their control in the development of swamp lands and their reclamation, and for other forms of waterway development which will turn these great destructive waters, which have every year or so fixed upon the country a loss of $200,000,000, from destroyers of wealth into creators of wealth.

Difficulty of Convincing Congress

It is true that it has been very difficult to impress Congress with the importance of this measure. But the action has not been adequate; we have simply the form of the organization with an appropriation of a hundred thousand dollars for organization and plans. The bill which I originally introduced provided for an appropriation of sixty million dollars for ten years, six hundred million in all.

Congress and the country stood aghast at the prospect of spending six hundred million dollars upon the development of our rivers. Now we have become so accustomed to big sums that I imagine there will not be the same apprehension regarding the huge figures. If we can afford to spend between sixteen and twenty billion dollars for our railways; if we can contemplate an expenditure by the railroads themselves of a billion dollars every year for additional equipment and facilities (and that is stated by the railway authorities as the amount that is necessary), we can certainly look with complacency upon the expenditure of sixty million dollars annually upon our rivers.

And if that amount is spent—though I favor even more—for ten years, under a comprehensive plan, with consecutive work and without political interference, the country will be amazed at the results. The rivers can carry the bulky traffic which now congests our rivers, that kind of traffic which is large in bulk and low in rate, the neglect of which, by giving preference to other traffic paying higher rates to the railroads, produced this condition of scarcity in the coal supply. It almost, at one time, paralyzed the industries of the country.

I think that the development of our rivers and, of course, the connection of them with canals, would have absolutely prevented this great congestion.

Just to give an illustration, when I was a member of the Inland Waterway Commission, appointed by Mr. Roosevelt, we sailed down the Mississippi River, and it was distressing to see how little that river was used. Only semi-occasionally would we come across any signs of navigation. One day I remember seeing fifty barges, each containing about a thousand tons of coal, going down the Mississippi River, having come originally from the Ohio, steered by a small tugboat. They were going down with the current, practically, without much use of motive power, the tugboat simply steering this immense raft of barges which preceded it.

Think how small the expense of that tugboat was; how few men were employed upon it, yet they were guiding fifty thousand tons of coal. A large car will carry fifty tons of coal; a train of twenty loaded cars is a fairly good train. That would mean twenty times fifty—one thousand tons. A train, therefore, would carry a thousand tons; this little tugboat on the Mississippi River guided fifty thousand tons.

This is a fair illustration of how the rivers can be used for distributing cheap products.

Chesapeake and Erie Canals

The Chesapeake & Ohio Canal has been for years and is being used for transportation of coal. That canal, I understand, is under the control of the Baltimore & Ohio Railroad and is a part of its system, but it is used largely in the transportation of coal.

Then there is the Erie Canal. I don't know whether that is used extensively in the transportation of coal or not, but, of course, you all know that it has been a tremendous factor in keeping down the rates, and it has also been a great factor in actual carriage of bulky products.

There are few other canals in the country of any great length. That is the difficulty. It is of little advantage to have merely a stretch of a hundred or two hundred miles on a river perfected for navigation, nor is it of much advantage to have a tax canal here and there; the rivers and canals must all be connected so as to form a continuous network of waterway, just as we have a continuous network of rails throughout the entire country. Of course, the mileage would not be as great as that of rails. The usefulness of these small canals built in ancient times, when water was about the only means of transportation, furnishes no argument against the large and comprehensive scheme I have presented.

Proposed Canals of National Importance

I have no doubt it would be very important to have a connected system of inland water route transportation all the way south from Boston to Florida. That can easily be done. They have connected, they have dug a canal through Cape Cod which shortens the distance from Boston to New York by many miles and avoids the fogs of Nantucket. Of course, Long Island Sound is a protected waterway, used so largely by vessels going through this canal.

Then we come to the Raritan River, flowing through New Jersey, serviceable for a connection with Delaware Bay, connecting with some other river, and finally with the Delaware River, which the Raritan Canal is designed to complete. There is also a canal to connect the Delaware backward with Chesapeake Bay; also another canal connecting with Pamlico Sound in North Carolina, etc.

Throughout that entire distance there can be a system of waterway transportation that would be protected from the storms of the ocean. We can go further and run a canal across Florida. I have been told it is considered entirely practicable on the Gulf of Mexico, on its northern shores, to have an inland waterway, connected system of bays and sounds, to be traversed by small boats.

Connecting Links of Prime Economic and Strategic Value

These canals will be used mainly for connecting either existing sounds and bays and gulfs, or linking great river systems. The Mississippi River connects with the Missouri River, and I presume that from New Orleans to the source of the Missouri River is a distance of three or four thousand miles. The Missouri River rises in Montana, but the source of the Snake River, on the Pacific Coast, is also in Montana. All that would be necessary would be to connect the head waters of each of these rivers by a canal such as Germany and Austria are now engaged in digging between the head waters of the Rhine and the head waters of the Danube. This would connect New Orleans practically by waterway with Portland, Oregon,

on the Columbia River, the Snake River being a branch of the Columbia.

Consider that one river and its development. The Columbia River is a very noted river emptying into the ocean near Portland, Oregon; Portland has been growing as a great commercial city. The Columbia River has a tremendous grade in some places, causing large falls. They devised a system there of getting around those falls by locks. Economically that great fall of water is of considerable value for the development of water power.

Improvement by Army Engineers

The Columbia River has been taken care of in a rather disjointed way through the Engineering Corps of the army, which is in charge of so-called river and harbor work. The upper part of the Columbia and the Snake, its tributary (the two belong together, traversing the States of Oregon, Washington and Idaho), is under the jurisdiction of the Reclamation Service, in the Interior Department, the Engineering Corps of the army being under the War Department.

The Reclamation Service of the Interior Department is seeking to solve the problem of distributing those waters which have their sources in the snows on the mountains over the arid plains for purposes of irrigation. Incidentally in connection with the construction of their dams for irrigation, they are developing water power to a very great extent.

Two Engineering Staffs Which Should Co-ordinate

Under our present system the two services (Engineering Corps of the Army and the Reclamation Service of the Interior Department) are proceeding absolutely without co-ordination or co-operation of any kind. That entire system of rivers—the Columbia and the Snake, with all their tributaries—should be treated under well-considered, comprehensive plans, whereby these two engineering services would share the making, and in the execution of which each service would do under primary plans the work coming within its jurisdiction.

That is a system of co-ordination which Brazil has sought to bring about, which has never been brought about by administration, and could not under existing law be accomplished through mere administration.

Coast and Geodetic Survey

In addition to those two services, there is the Coast and Geodetic Survey that is at work on problems relating to the Columbia River—that is, jurisdiction over the rivers. The Geological Survey is also making studies upon the question of waters, their sources, utilization and development. Yet each of these capable scientific services is conducting its work without any co-operation or co-ordination with the other. It is the purpose of this movement to bring about absolute co-operation not only between these scientific services of the nation, but also to bring about their co-operation with similar agencies in the State.

In Oregon they have a waterway commission which is doing good work and also making a study of the question of water power development and irrigation. There is no reason why these two sovereigns, instead of standing apart and eyeing each other jealously regarding their respective jurisdictions, shouldn't co-operate in the interests both of the Nation and of the States. It is the purpose of this movement to accomplish that.

The Lower Mississippi as an Arm of the Sea

Potential Value of the Lower Mississippi to the New American Merchant Marine—How Ship Lines Can Make Immediate Use of this Waterway

BY M. VON PAGENHARDT*

CAIRO, situated at the junction of the Mississippi and Ohio Valley, and St. Louis, at the mouth of the Illinois and the Missouri, are the logical northern termini of an intensified modern Mississippi River navigation. More than 700 miles from seaboard as the crow flies, only 250 miles from Chicago, it could be declared seaboard by a stroke of the pen simply by practically applying the water rates effective between New Orleans and the Atlantic or Pacific seaboard to St. Louis itself, or, what would be the same, by the ship lines' partial absorption of the present proportional freight rate between St. Louis and New Orleans on all commodities delivered at Cairo.

Four newly developed factors make this possible. The now definitely assured American merchant marine, the creation of the United States Shipping Board, the continued and growing congestion in Atlantic seaports and the gradual modernization of the Mississippi River's floating equipment. An outlet to Gulf harbors must be arranged which is at once effective, which will from the outset commandeer the freight from a large producing area without great soliciting efforts, by making the new routing extremely attractive, and the extraordinary cheapness of transportation on the Lower Mississippi offers such an opportunity.

*Naval architect, 2073 Railway Exchange Building, St. Louis, Mo.

As a matter of fact, this Lower Mississippi between Cairo and New Orleans is so wide, so deep and has so little slope that extremists have in the past advocated a deep sea channel for seagoing ships. That is out of the question and at all times undesirable, even if the river were 24 feet deep, as both seagoing and lakegoing equipment represent too great an investment and are too urgently needed elsewhere ever to be used on the river. But the Mississippi River is in its present state of improvement sufficiently deep and wide—and has been for the last ten years—to permit a barging of freight on as large a scale as in channels connecting Raritan Bay with New York Bay, where over 28,000,000 tons were moved in the fiscal year of 1915, representing freight delivered in barges and lighters from river terminals to shipside. There is no reason why the same barging or lightering should not be carried out between Memphis, Cairo, St. Louis and New Orleans. The distance is a little greater—to be exact, over 1,000 miles greater—but that does not materially change conditions. The unique condition of the Mississipi River, running from the thickly populated States of Illinois and Iowa without any natural hindrance through a barely settled country to the Gulf, makes this river a natural, long-distance freight carrier, predestined to carry freight cheaper than over the Great Lakes.

The navigation of the Lower Mississippi, developed properly, will represent quite a new and unprecedented form of water transportation—not a transportation of freight in bulk, like ore and grain, as on the Great Lakes; not a transportation of building materials, fertilizer, rock and lumber, as on most canals—but a long-distance barging and lightering of all commodities similar to the business carried in the port channels of New York harbor, comparable only to a hundred-track railroad, to a rapid-transit line, connecting two points 1,000 miles apart, carrying all the goods carried by railroads, manufactured products as well as raw material, crude and refined oil in tank barges; in short, all freight for import and export and coastwise trade, crated and packed properly.

Long-Distance Lightering

This comparison of the almost canalized Lower Mississippi with the channels connecting New Jersey with New York harbor is no exaggeration. In either case, the freight commodities are loaded from the freight terminals into barges, the barges are towed a distance of twenty and forty miles to shipside, where they are unloaded into the ships. The terminal handling charge is the same in either case, and the only difference is the increased distance. Long distances are for the modern transportation expert almost welcome hindrances; greater distances reduce the cost per ton mile, permits the use of a larger equipment, a greater storage capacity, a greater flexibility of the movement. The actual transportation charge on the Great Lakes never exceeded 1 mill per ton-mile, and is now considerably below that amount. Translated into railroad terms, such a charge would be equal to 5 cents or 10 cents per hundred weight and represents only a fraction of the handling and terminal charges. And there will be a time when, similar to the development of the Great Lakes shipping industry, this transportation cost can be cut in two.

It should not be forgotten that the influence of the tide is visible at the mouth of the Red River, 300 miles from seaboard, and that the Cairo level is not higher than 300 feet above seaboard, representing an average slope of 3.5 inches to the mile, producing a current velocity of not exceeding 5 miles per hour and averaging 3 miles per hour. Such a river can be compared with a bay extending way inland similar to the Chesapeake Bay, with the only difference of a little more current and throughout shallower water. Not to use such an opportunity seems a crime on the natural advantages offered by nature.

General Plan

It is proposed to build towboat and barge units of 8,000 to 10,000 tons capacity each, which, controlled by the Shipping Board, radiate from the port of New Orleans, carrying railroad freight from St. Louis, Cairo and Memphis to New Orleans shipside, and *vice versa.* The actual cost of water transportation, if confined to the lower portion (St. Louis-New Orleans), a distance of 1,150 miles—similar to the distances on the Great Lakes, as Chicago-Buffalo, 890 miles; Duluth-Buffalo, 990 miles, and similar in original and eventual draft—will not exceed $2.00 per ton, or 10 cents per hundredweight, so that the ship lines could well afford to absorb the transportation charge wholly or at least to such an extent as to make the new terminals of St. Louis, Cairo and Memphis act like magnets for all export and coastwise freight originating in the whole central part of the United States, thus acting as a gradual relief of the continuously growing congestion on the Atlantic seaboard.

The establishment of such low water rates on this 1,150-mile stretch (St. Louis-New Orleans), duly filed with the I. C. C. and co-ordinated with the through and export freight tariffs of the railroads, will prove to be the only certain method to insure the ship lines visiting the port of New Orleans the required return freight. The port of New Orleans has realized the necessity of utilizing the Mississippi River long ago; this plan is offered as a further step in the river's proper utilization. The barging of freight on the Lower Mississippi will automatically reflect itself in the Upper Mississippi, Missouri and Ohio; it will further make New Orleans a redistributing center in the South for goods originating in the central part of the United States, and it will augment in leaps and bounds freight hauled by rail paralleling the Mississippi to a port of New Orleans frequented by regular ship routes. It can well be said and proven by statistics that wherever water-borne freight competes successfully with rail freight the freight hauled by rail grows in the same proportion as the freight carried by water. All students of transportation concur in this.

There never has been a real difficulty in the handling of freight wherever facilities are provided. The water transportation does not offer any real difficulty less than the navigation of the Great Lakes or on salt water. Freight once loaded in properly built, non-sinkable, non-burnable river barges, pushed by powerful, modernized steel towboats, will arrive on schedule at the other terminal point. Always in immediate vicinity of the shore, always near a telephone, never exposed to a treacherous sea, they could hardly be subject to any loss when constructed with the same care and foresight as Great Lakes or seagoing ships. There is no excuse, however, not to build them with the same care and foresight as ocean-going ships, just because they operate on a river. Only this negligence of construction accounts for the greatest part of the loss of river floating equipment.

Cost of Transportation Low

Neither can the cost of transportation be any greater than anywhere else as long as 8,000 to 10,000 tons are moved by a single operating unit of 2,000 horsepower similar in proportion to any good-sized freight boat operating on the Great Lakes or ocean, and as long as the channel is maintained at its proper depth, which it has held now for the last ten years. Neither can the difficulty be in the terminal situation. At the lower end, the port of New Orleans with its miles of improved waterfront, its docks and warehouses, its natural protection from the sea, its remarkable cheap fuel, coal from Birmingham and fuel oil from Texas and Mexico, its comparative cheap labor market and repair docks.

At the upper end, St. Louis and East St Louis, with a great number of river and rail transfer points, commonly terminals and the new permanent city dock under construction, the natural converging point of all railroads coming from east, north and west, further the various transfer points between St. Louis and Cairo, offering in their dormant potentiality an excellent opportunity to coordinate the interests of industries and transportation of inland and seaboard by the utilization of river and rail transfer.

The only difficulty is the now fortunately disappearing general lethargy in the matter of river navigation, an aloofness growing out of the feeling that past river navigation has failed and that modern river navigation has not yet demonstrated its success. It is realized that river navigation is not merely a matter of physical transportation of commodities, but that it requires a change in the country's transportation methods.

The growing need of additional transportation facili-

ties changes this attitude both on the side of railroads and shippers, and, with the awakening of this realization, all previous difficulties seem to disappear.

The problem reduces itself to a very simple equation:

1. To construct the required towing units of proper dimensions, power and security.

2. To construct or improve required terminal facilities.

3. To arrange a plan of operation of the barge line whereby the railroads participate with the ship lines under the control of the Federal Government.

4. To file a through tariff with the Interstate Commerce Commission.

The benefits accruing from this procedure are:

1. Additional transportation facilities.

2. Release of corresponding railroad facilities.

3. A saving in transportation charges.

4. A relief of the congestion in Atlantic seaports.

This solution should not be accepted as equally true for all rivers where local conditions are entirely different, but it is merely intended for the Lower Mississippi, for a "rapid transit" connection between two terminal points "inland and seaboard," on this "arm of the sea," with each towing unit representing and, therefore, relieving three to five railroad trains elsewhere, with each towing unit representing a saving in time, a large saving in transportation charges and a relief of congestion in Atlantic ports.

The reason for the inevitable success of this barging plan rests in the recommended cut in combination water and rail rates and in co-operation with the ship lines.

In the movement of freight between local points a reasonable differential of 20 or 25 percent is all that can be expected. In fact, a greater differential is hardly possible, in view of the already lowered rail rates, lowered to meet this potential water competition.

But in the movement of export, import and coastwise freight, the ship lines can well afford to absorb a part of the barging expense, as this alone will attract a sufficient tonnage to guarantee the required balanced tonnage movement, and this in turn will increase the barge tonnage to an extent where the transportation expense per unit weight is small and only a fraction of the total revenue of the through rate.

By this movement seaboard rates or "almost seaboard rates" will apply on all export and coastwise freight as far inland as St. Louis, 250 miles from Chicago. Freight is then compelled to use the river as far as the beneficial influence of this lowered export rate applies. As far north as St. Paul, as far east as Pittsburgh freight would seek the Mississippi River to reach seaboard, instead of seeking seaboard at the Atlantic. This in turn would develop the use of all other Western waterways by private enterprises; the Ohio, the Tennessee, the Upper Mississippi, the Illinois, the Missouri, the Arkansas, the Black River and the Red River, in order to join with their own barges the grand procession of towing fleets on the Lower Mississippi River and benefit from the natural advantage of low cost of transportation on this waterway, which in reality is an open arm of the sea.

The Fallacy of Concrete Ships

Optimism Regarding Success of Large Ocean-Going Concrete Vessels at Present Unjustified

BY H. A. EVERETT*

We are hearing much now-a-days about ships to be built of reinforced concrete, and as a rule the presentation of the subject has a very unprofessional bias toward extreme optimism. This is not to be wondered at when it is considered that those most directly interested in the new project fall into two classes, both of which are interested in selling something—first, the cement companies, who naturally are interested in anything which augments the usefulness and sale of cement; and, second, the constructor who has a system of construction which he wishes to sell or build under, with consequent remuneration to himself. We rarely read anything that is not laudatory to this so-called new system, and the absence of adverse comment is misleading in that it gives the impression that there *is* none. This is unfortunate, as both sides of any question are always desirable, and I wish to direct attention to a few features wherein this construction is either deficient or open to serious question.

It may be well to first note that there has not yet been built and put in operation a seagoing concrete ship as large as 200 feet length. The entire construction up to the beginning of this year consisted of barges, scows, canal boats and small craft under 200 feet length, the majority of which are intended for quiet water or coastwise operation.

One need not deny the usefulness of reinforced concrete for heavy barges, etc., for still-water usage, though even there our experience with those built for the Panama Canal was not entirely satisfactory, but when we begin to talk of large seagoing ships—and by large let us say anything over 250 feet, though that is woefully small for steel ships—we then are approaching an absolutely untried field and one which, if discouragement and disaster are to be avoided, must be approached sanely and gradually.

The present time is the psychological one to advance any project for ship construction which will use materials and labor that do not enter into the construction of the regular steel ships because of the immense pressure which the war has put upon that industry, and we are now willing to try out projects that in times of less urgent need would not be considered; moreover, economic conditions have forced an artificial level to both material and labor for steel fabrication. There are bound to be, therefore, sporadic cases of completed units which, while pointed to with pride as demonstrating the complete success of the future industry, are nevertheless only experiments, simply demonstrating the possibility of actually constructing such a unit and giving no information whatever as to the later success of the vessel from the technical or economic point of view. We are informed, for instance, of large vessels (up to 3,000 tons) being built in Sweden, and also of a large vessel (5,000 tons) being built in this country, all of which certainly are in the above-mentioned category; and while those financing the proposition and the

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construction deserve the greatest credit for their experimental generosity and engineering ingenuity, they are certain to be confronted with many unlooked-for defects and difficulties.

One of the best gages for measuring the merit of new propositions in hull construction is the attitude of the various large classification societies; and while they have been accused in years past of undue conservatism, their attitude since the war and its attendant abnormal demand for new construction has been as progressive as is consistent with safety of life at sea. Of these, the majority will not class this construction for ocean-going, self-propelled units; some have been willing to class vessels of sizes less than 150 feet length for ocean-going service, but for a very brief term subject to extension on satisfactory survey, and societies in Great Britain, Denmark and Norway have recognized its usefulness for non-propelling barges, etc.

Principal Advantages Claimed

The advantages claimed by the most optimistic reinforced concrete advocates may practically be boiled down to four major claims: 1, availability of material; 2, availability of labor; 3, cheapness of repair and maintenance; 4, permanence of construction. Of these, the first (availability of material) may go unchallenged. It is an advantage.

The second (availability of labor) is by no means so readily accepted. There is a serious shortage in this country now of good carpenters accustomed to working on reinforced concrete; in addition, the work on ships is a highly specialized form of concrete construction requiring especially good fabrication and a corps of artisans whose training must be specialized to nearly the same extent as the ordinary workman on a steel hull, whether the work be done with a "cement gun" or the more orthodox method of using forms.

Cheapness of repair, the third item, is questionable, for the proper repairing of a reinforced concrete structure designed to be highly stressed is not simply a matter of putting on a few hodfulls of cement. If the structure has been seriously damaged the reinforcing must be repaired, and it is improbable that the cost of repair work will be less than for steel construction.

Permanence of Concrete Needs Verification

Considering the fourth claim—i. e., permanence—we are told that the ship is to be a "monolith," a "rock," and "with all a rock's permanence." Anyone who has to do with concrete structures, even ashore, realizes that any part subjected to constant shock and abrasion deteriorates. When one comes to a seagoing structure we have vastly augmented deteriorating forces, due to the repeated varying stresses of large magnitude, the effect of salt water and dockage and handling, wear and tear.

In a structure as complicated as any ship of reasonable size must be, there are numerous webs and corner connections which, as in an iron casting, are apt to suffer severe stress and fracture from expansion and contraction due to temperature change only. In as relatively simple a structure as a dry dock, trouble is experienced in allowing for expansion and contraction due to changes of temperature, and with a complicated monolith like a ship there is sure to be cracking of cement at such places, with the attendant rapid deterioration of the reinforcing.

Much more subtle and persistent, however, is the deterioration of the whole structure due to its immersion in salt water. In a very illuminating article recently published in the *Journal of the Franklin Institute** our attention is directed to the serious effect of salt water on reinforced concrete.

The author first calls attention to an investigation by the U. S. Bureau of Standards (Technical paper 12) on the "Action of the salts in alkali water and sea water on cement," which found that any cement mortar may be destroyed if a sufficient amount of salt accumulates and crystallizes out. He calls attention to the markedly prevalent cracking of reinforced concrete structures in the Philippines reported by J. L. Harrison, district engineer, Iloilo. (Bulletin of Bureau of Public Works, October, 1916), of which a study "showed no structure showing rusted steel to be free from salt," and continues as follows: "It is clear that reinforced concrete which comes in contact with brine or sea water, unless rendered absolutely impervious, will commence to deteriorate as soon as the brine comes in contact with the reinforcing rods; for, as both iron oxide and the hydrated oxide occupy a larger volume than the corresponding amount of iron, there will be developed an enormous expansive force which is sufficient to crack the strongest concrete and force it away from the reinforcing rods. The more porous the concrete, the more rapidly will this action take place. Indeed, the writer is familiar with cases of cinder concrete structures, in contact with brine, which have shown signs of advanced deterioration at the end of a year.

"Regarding the waterproofing of concrete, it should be pointed out that an impervious concrete is probably never obtained outside the laboratory. The average concrete is practically never waterproof. Although there are many substances on the market for rendering concrete waterproof, the majority of them are far from satisfactory. A number of such instances has been investigated by Brown (*The Electrician,* 69, 615, 1912), who points out that all waterproofing materials will sooner or later hydrolize, crack or disintegrate.

"Since most concrete is more or less porous to moisture, and since iron undergoes gradual decomposition in the presence of salt water, with consequent expansion in volume, it is to be expected that reinforced concrete which comes in contact with brine or salt and moisture will ultimately disintegrate. It is not surprising, therefore, to find throughout the country reinforced concrete piers, sea walls and buildings in the neighborhood of the ocean in various stages of deterioration. The cracks which occur in such concrete usually run parallel to the reinforced rods. These cracks are very narrow at first, but as the decomposition of the iron progresses they become iron-stained, gradually increase in width, and finally the concrete is forced so far from the reinforcing rods by the pressure of the accumulating iron oxide that large pieces of it break off."

The paper ends with a list of the citations of many cases, giving photographs, in which deterioration and disintegration of the concrete has been due to the action of salt water superficially applied.

In view of this, it is hard to see any ground for the claims of such remarkable longevity as are advanced, and the slogan "concrete for permanence" certainly needs verification before being accepted as applying to ships.

A ship is built to carry cargo, and anything which detracts from her carrying capacity is an economic loss. Concrete ships are bound to be much heavier than steel or wooden ships when the size is over 100 feet length. A recent estimate* of a specific reinforced concrete barge 120 by 28 by 8 feet put out by the designers gave the weight as 259 tons, as against 135 and 151 tons for

* "The Deteriorating Action of Salt and Brine on Reinforced Concrete," by H. J. M. Creighton, *Journal of the Franklin Institute,* November, 1917.

* "Reinforced Concrete for Shipbuilding," by Allen Hoar, MARINE ENGINEERING, July, 1917.

wooden and steel construction for same barge, and as larger and more complex units are discussed there is nothing to indicate a transference of this debit to the side of the steel ship. One has only to bear in mind that the tensile strength of reinforced concrete is *that due to the steel in it* to realize that for equal sized vessels there must be as much steel in the strength members of the concrete ship as in the steel ship, and the concrete becomes so much additional weight which must be paid for in reduction of weight elsewhere or in reduced cargo-carrying capacity. The rule of the Union of Danish Engineers (one of the few technical bodies formulating rules for reinforced concrete ships) limits the stress in the steel work to 8 tons per square inch, when the calculation is made in the orthodox way, as for steel ships, by assuming the ship on a wave equal to her length and loaded with a homogeneous cargo. Consider this in comparison with the normal allowance for plain steel ships of 6 or more tons. Moreover, the principal stresses which the seagoing hull structure must withstand are tensional, which is the sort of stress that reinforced concrete is least suited for.

The absurd extent to which the optimism of the proponents of concrete for ships has led them is illustrated in the following list of reasons recently published "Why concrete fits shipbuilding needs." In parallel columns I have ventured equally brief comments, which, like the original list, are given without experimental or engineering evidence, but which, unlike the original list, can be verified by engineering experience:

CONCRETE SHIPS	STEEL SHIPS
1. Concrete ships are fireproof.	So are steel ships.
2. Wood-boring worms cannot attack the hull.	Nor a steel ship.
3. Concrete ships are ratproof.	So are steel ships.
4. Concrete ships require practically no maintenance.	Doubtful; authoritative operating reports are lacking.
5. Construction methods are economical and the cost is low.	The cost is higher than for steel or wood.
6. Concrete ships can be built quickly.	Questionable; but so can steel or wood.
7. Concrete ships will neither rot nor rust.	They will deteriorate.
8. Calking, painting and similar maintenance of the hull is unnecessary.	Questionable.
9. Concrete ships will withstand very rough usage.	Not borne out by many cases.
10. Materials required may be obtained readily anywhere at low cost.	Granted.
11. Less labor is required and cheaper labor may be employed.	Questionable.
12. There is no likelihood that the hull of a properly designed concrete ship will buckle.	If properly designed to withstand seagoing stresses, the weight is excessive.
13. Because of the smooth surface and the absence of angular projections, skin friction is greatly reduced.	The difference in skin friction, if any, is in favor of the steel ship well painted.
14. Concrete vessels may be floated before completion.	So can steel or wooden.
15. Concrete vessels are lighter than similar ones of wood.	All figures available give the reverse conclusion.
16. Barnacles and other sea growths find conditions unfavorable to their growth.	Questionable.

To sum up briefly we are justified in expecting success for reinforced concrete construction for barges, still-water craft and perhaps small ocean-going craft of simple form, but are entirely unjustified at the present time in expecting large ocean-going craft to be successful, and should not be led astray by undue optimism.

A dirty gage class is dangerous and when cleaning it a wooden stick with waste should be used and never a wire or any metal rod.

When checking a fire by opening the fire door it is not wise to open it wide all at once. Open it a little at a time or you may start your tubes leaking.

British Marine Engineering Design and Construction Committee

As a result of the conference convened by the Institution of Naval Architects, a committee has been formed consisting of representatives of the various shipbuilding and marine engineering societies, the Board of Trade and the registration societies "to standardize rules governing the design and construction of marine engines and boilers upon a practical and scientific basis, so that they may be acceptable to shipowners, the Board of Trade, the classification societies and other interests concerned."

There are at present four different sets of rules in force governing the design and construction of marine engines and boilers, all of which aim at securing safety and efficiency of marine machinery, and it is believed by many that one set of suitable rules having a scientific and practical basis should be secured for all purposes. It is for the preparation of such rules that the committee has been formed. The committee is composed of the following members:

Institution of Naval Architects.—A. E. Seaton, consulting engineer (chairman); Professor W. E. Dalby, M.A., F.R.S., dean and professor of engineering, Imperial College; H. Barringer, consulting engineer; R. Leslie, superintendent engineer of the Peninsular and Oriental Company.

Institution of Engineers and Shipbuilders in Scotland.—James Brown, director of Scotts' Shipbuilding and Engineering Company; A. Cleghorn, director of the Fairfield Shipbuilding & Engineering Company, Ltd.; J. S. Kincaid, director of John G. Kincaid & Company, Ltd.; W. G. Weir, director of David Rowan & Company.

North-East Coast Institution of Engineers and Shipbuilders.—F. T. Dickinson, chairman of John Dickinson & Sons, Ltd.; Andrew Laing, C.B.E., managing director of the Wallsend Slipway & Engineering Company, Ltd.; D. B. Morison, managing director of Richardsons, Westgarth & Company, Ltd.; Professor R. L. Weighton, M.A., professor of engineering, Armstrong College.

Institute of Marine Engineers.—B. P. Fielden, superintendent engineer, Atlantic Transport Company; T. McLellan, superintendent, the Eagle Oil Company; W. J. Veysey Lang, superintendent engineer, Watts, Watts & Company, Ltd.; A. Walker, superintendent engineer, Strick & Company, Ltd.

Liverpool Engineering Society.—W. J. Willett Bruce, superintendent engineer, White Star Line; Sterry B. Freeman, superintendent engineer, Alfred Holt & Company; J. Hamilton Gibson, engineering manager, Cammell, Laird & Company, Ltd.; J. B. Wilkie, superintendent engineer, Elder, Dempster & Company, Ltd.

Board of Trade (Marine Department).—T. Carlton, engineer surveyor in chief.

Lloyd's Register of British and Foreign Shipping.—J. T. Milton, chief engineer surveyor (deputy chairman and honorary treasurer).

British Corporation for the Survey and Registry of Shipping.—W. Rowan Thomson, member of the committee.

Bureau Veritas, International Register of Shipping.—John Gravell, chief representative in the United Kingdom.

Barrow District.—J. McKechnie, managing director, Vickers, Ltd.

Belfast District.—C. E. Allan, director, Workman, Clark & Company, Ltd. (corresponding member).

Steel Makers.—B. Talbot, managing director, Cargo Fleet Iron Company; R. J. Butler, C.B., director, John Spencer & Company.

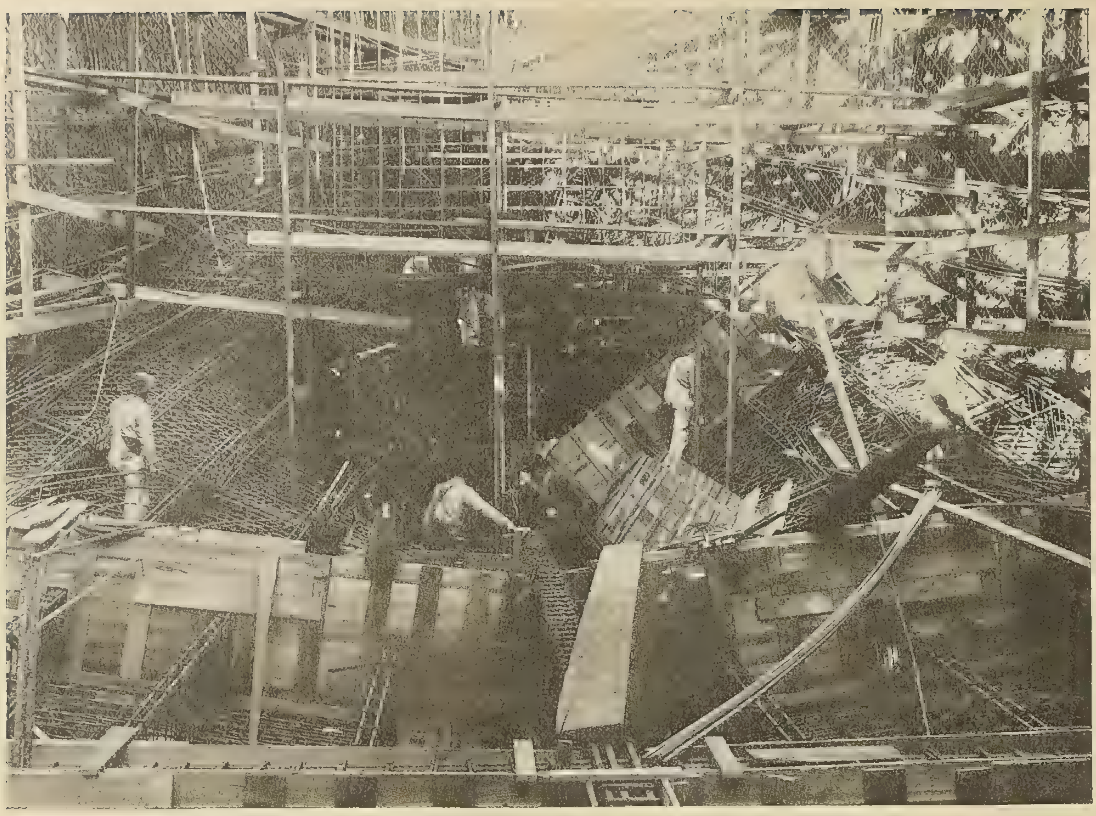

Fig. 1.—Building Molds Around Steel Work for Pouring Concrete

Reinforced Concrete Cargo Steamer

Plans and Specifications of 5,000-Ton Vessel Building by San Francisco Shipbuilding Company in California

REFERENCE has already been made in previous issues to the construction of a 5,000-ton reinforced concrete steamship by the San Francisco Shipbuilding Company at Redwood City, Cal. In our last issue photographs were published showing the progress of construction of this vessel, while in this issue we are able to reproduce the general plans of the vessel, together with the following data from its specifications:

The vessel is a single-screw steamer with straight stem and cruiser stern, rigged with two pole masts fitted with cargo booms. The propelling machinery is to be located aft, while the deck officers will be quartered in a house amidships, and the engineers, steward and crew in houses aft.

The general dimensions are as follows:

Length between perpendiculars	320 feet
Length over all	336 feet 3 inches
Breadth, molded	44 feet 6 inches
Depth to main deck	30 feet
Depth to lower deck	21 feet
Deadrise	9 inches
Designed load draft	24 feet
Deadweight carrying capacity at above draft	5,000 tons
Horsepower	1,750
Speed	10 knots

The hull is of reinforced concrete, the reinforcement consisting of deformed steel bars accurately placed in molds and carefully wired together, while the concrete will be carefully poured into the forms and well puddled with steel rammers. In addition to the bar reinforcement, all of the outside shell and deck will be further reinforced by 6-inch by 6-inch mesh No. 6 galvanized iron fabric placed ¾ inch from the outside surface of the concrete.

The outside mold for the hull was built, first using 2-inch by 4-inch studs inside and outside with ⅞-inch sheathing. The studs were placed 2 feet on centers and wired through every 18 inches. Wood spreaders are used throughout to be taken out after the concrete is poured, great care being exercised to see that all of these spreaders are removed as the pouring progresses.

Along the sides of the building ways, about 2 feet outside the mid section line, were erected 8-inch by 10-inch timbers 36 feet long, trussed across at the top 16 feet on centers. These timbers were accurately set and carefully alined, since the general interior dimensions were taken from their center lines.

The specifications provide that no concrete is to be stripped until the entire structure is poured and set for at least thirty days.

Materials

The large aggregate consists of No. 4 crushed limestone not exceeding ¾ inch and absolutely free from dust. The sand used consists of Grant Gravel Company's topping sand accurately graded from ¼ inch down to that which passes a No. 60 sieve.

The cement used is Portland cement of local manufacture, especially ground according to directions of the Smith Emery Company's testing engineers, special care being taken to have a minimum of magnesium in its com-

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5,000-TON REINFORCED CONCRETE CARGO STEAMSHIP

Building at Redwood City, Cal., by San Francisco Shipbuilding Company

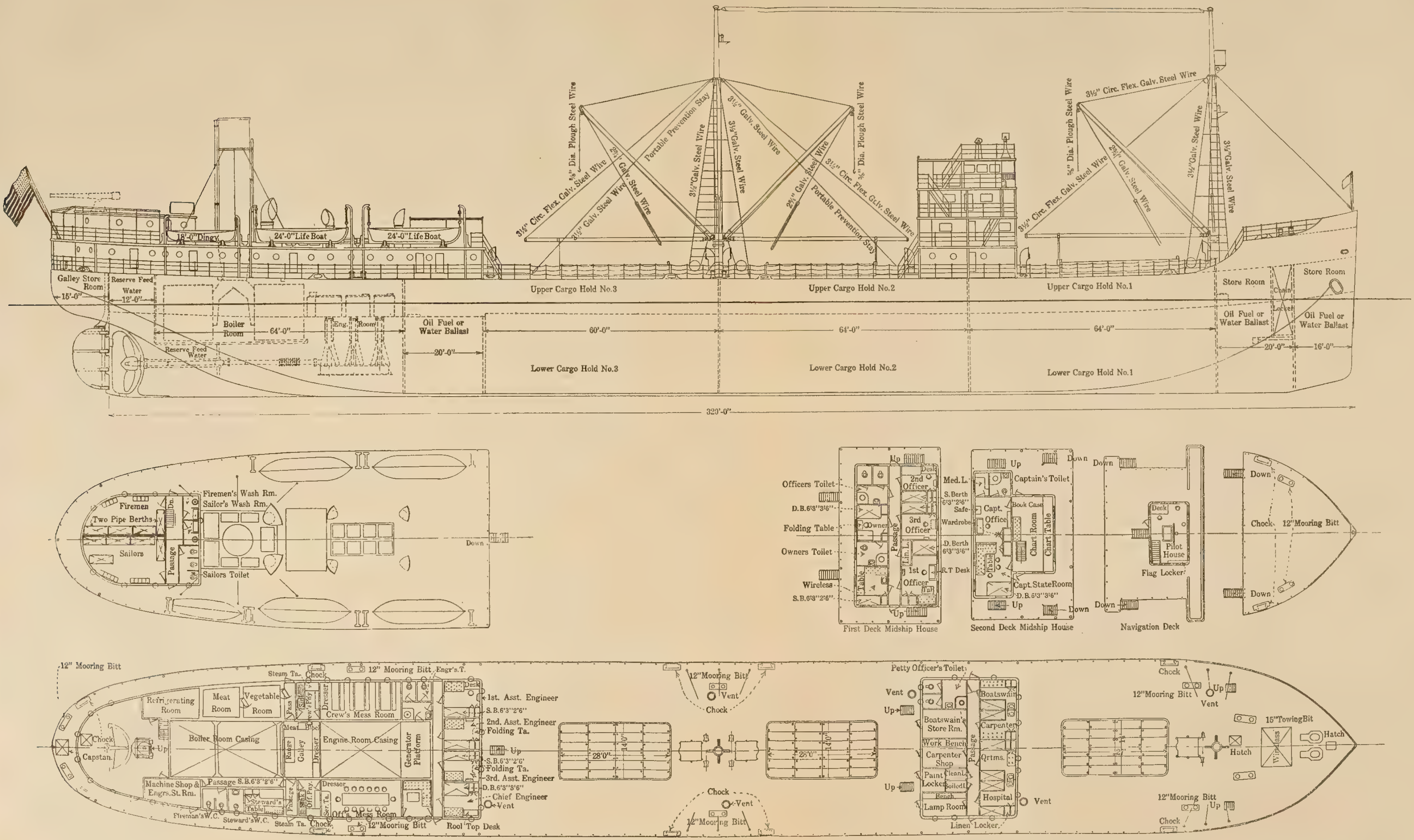


Fig. 2.—Outboard Profile and Deck Plans

position. All of the cement is carefully tested at the mill and again on the job.

The material will be waterproofed by an integral waterproofing material, consisting of a special compound supplied under the directions of a competent chemist supervising the work.

The proportions of the cement aggregate are as follows: One part cement; 1½ parts fine aggregate; two parts coarse aggregate.

The concrete is mixed in a rotary batch mixer with pure fresh water free from all chemical impurities, as little water being used as possible to make the concrete flow.

The concrete is carefully poured into the forms and well puddled with steel hammers. During the pouring, the sides of the outside forms of all walls and beams are hammered to insure the density of concrete at the surface and the prevention of voids.

The hull is so located on the building ways that the bottom is 6 feet above the ways and carefully shored. After the concrete has set a sufficient length of time, sections 8 or 10 feet in length will be stripped and the outside coating applied. As soon as the outside coating has set and is finished, the blocks for launching will be placed under the finished portion of the hull, and sufficient scaffolding erected to hold the structure in place. When this is done another alternate section will be stripped, and the same operation repeated until the full length of the boat is resting on the launching ways.

After the surface is stripped and carefully sand-blasted to insure a good, clean bond, an outside finish will be applied with cement guns. The mixture to be used will be one part cement, two parts river sand free from mica and other impurities, the materials to be mixed dry and applied under pneumatic pressure, adding the water at the nozzle. This coating of "gunite" is not to exceed ½ inch in thickness.

As soon as this outside skin has attained its final set, which should be in four or five hours, it will be carefully wet down and kept soaked with water for a period of five days. When the outside skin is sufficiently set it is to be rubbed down with emery blocks by hand until the surface is smooth.

General Arrangement

The hull is subdivided into nine watertight compartments by eight transverse bulkheads of reinforced concrete. The upper deck is of reinforced concrete, while there is a lower deck made of wood. Three large cargo hatches are provided, served by cargo booms of 3 tons capacity, fitted to the masts and operated by double-drum steam winches.

Fuel oil tanks are located in the hold, one forward of the engine room bulkhead and one aft of the collision bulkhead, as shown on the plan. Fresh water will be carried in the hold aft of the boiler room bulkhead, and also in wooden tanks in the engine and boiler room. The forepeak tank will be arranged for use as a ballast or fuel tank.

The stem of the vessel is of reinforced concrete, covered with a ⅜-inch steel plate shoe. The stern frame is of cast steel fitted in two sections. The rudder is of the single-plate type.

The engine and boiler casing in the 'tween decks is of reinforced concrete, while above the main deck it will be of wood lined with sheet iron. The chain locker, located aft of the collision bulkhead, is also constructed of reinforced concrete.

Propelling Machinery

Propulsion will be by a single screw of cast iron of the four-bladed solid type about 14 feet 7 inches diameter, driven by a triple-expansion surface condensing engine, with cylinders 24 inches, 39 inches and 65 inches diameter, with a common stroke of 42 inches, supplied with steam from two three-furnace, single-ended Scotch boilers, each 14 feet 6 inches diameter by 12 feet 9¼ inches long. Piston valves will be fitted to the high and intermediate pressure cylinders of the main engine, while a double-ported slide valve will be fitted to the low pressure cylinder. The valves will be actuated by Stephenson link motion with double bar links. The condenser, which will be independent of the engine framing, will have about 2,000 square feet of cooling surface. The air pump, two feed pumps and two bilge pumps will be driven by a pump beam from the low pressure crosshead of the main engine, while the circulating pump will be of the centrifugal type direct connected to a vertical steam engine.

The crankshaft of the main engine will be 13 inches diameter in the journals and 13¾ inches in the webs. The

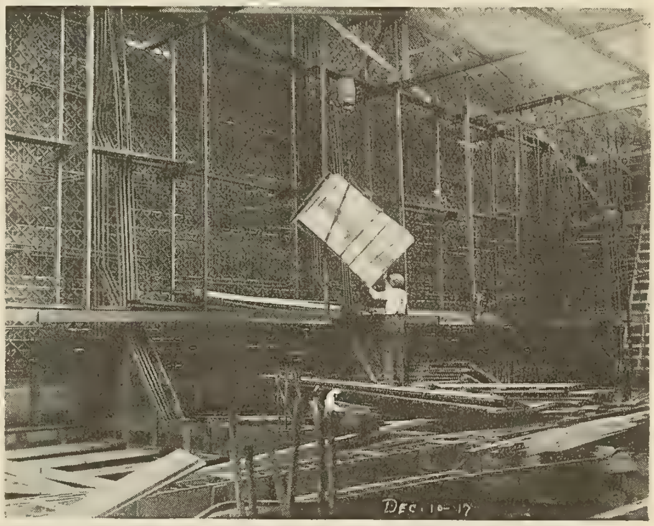


Fig. 3.—Interior of Hold with Reinforcement in Place

thrust shaft will be 13¼ inches between the collars, tapered at each end to about 13 inches diameter. The line shafting will be 12½ inches diameter and the tail shaft of 14 inches diameter.

The following pumps will be provided:

Pumps

One double acting duplex ballast pump and one double acting feed pump to be supplied, each with chamber, bucket, valve seats and rod of brass, ballast donkey valves of india rubber, and those of feed donkey of brass.

Duplex ballast pump to be 12 inches by 8½ inches by 12 inches, or equal capacity, to draw from sea, bilges and ballast tanks, and to discharge into condenser, ballast tanks, fire main, overboard, and to sanitary line.

Duplex feed pump will be 10 inches by 6 inches by 12 inches, or equal capacity, and draw from condenser, fresh water tanks, from sea and from boilers, and to discharge overboard, to feed heaters, to boilers, auxiliary line to donkey boiler and to fresh water tanks.

There will also be installed one duplex oil trimming pump, 6 inches by 5¾ inches by 6 inches, which will draw from the main oil fuel tanks and deliver to settling tanks in engine room.

There will also be provided two duplex fuel oil pumps, 5¼ inches by 3½ inches by 5 inches, to draw from settling tanks, and deliver to fuel oil heaters and boilers.

The vessel will be equipped with an electric lighting plant, refrigerating plant, steam heating system and steam steering gear.

The Beardmore Marine Engine*

Two-Cycle, Hot-Bulb Type Oil Engine Developing 160 Brake Horsepower at 280 Revolutions per Minute

ONE of the outstanding developments of recent times in marine propulsion is undoubtedly the greatly extending sphere of application of the semi-Diesel or hot-bulb type of oil engine, together with the rapid increase in power developed per unit. Quite recently this type of engine was universally regarded as being suitable for the development of only relatively small powers, say 25 brake horsepower to 30 brake horsepower per cylinder, but recent modifications in design and the virtues of rigid simplicity have brought it greatly into favor even for powers up to 130 brake horsepower per cylinder.

The great majority of marine semi-Diesel engines have points of similarity in the system upon which they work, and practically all are of the two-stroke cycle, utilizing the enclosed crank chamber for the compression of scavenging air. The "Beardmore" engine, which we illustrate on page 67, has been designed essentially to meet the peculiar requirements of marine propulsion, and is the result of much experience with this type of engine installed in yachts, coasters, lighters and fishing vessels. It is particularly suited to consume fuels ranging from 0.8 to 0.9 specific gravity, but can be adjusted to use either slight lighter or heavier oils. Working on the two-stroke cycle, it develops 160 brake horsepower while running at 280 revolutions per minute. This relatively slow speed of revolution is, of course, conducive to high propeller efficiency. As all bearing surfaces are liberal and materials carefully selected, an outstanding feature of the engine is its capacity for long and hard service. The engine is directly reversible by means of compressed air, and requires no disconnecting clutch between the engine and propeller, the latter advantage being one that appeals very strongly to marine engineers in general and oil-engine users in particular. Figs. 1 to 3 on the opposite page give sections and elevations of the engine, Figs. 5 to 9 are details of the main valves, and Figs. 10 and 11 are diagrams from the cylinder and crank chamber.

Cycle of Operations

In the main engine there are four cylinders, each 11 inches diameter by 15 inches stroke, and the cycle of operations may be briefly described as follows, the reference numbers being those shown on the section of one of the cylinders in Fig. 1: During the upward stroke of the piston, air is drawn through non-return valves into the crank chamber 1, to be compressed on the downward stroke and admitted into the cylinder at the correct moment through scavenging air ports located directly opposite to the exhaust ports 2. These ports are covered and uncovered by the piston, on the top of which a deflector is arranged, to give to the air blast the direction most suitable for efficient scavenging. While the under side of the piston is performing the functions of a scavenging air pump, the upper side compresses the contents of the previously scavenged cylinder on the upward stroke in preparation for the downward or power stroke. A separate fuel pump is provided for each cylinder, and once in each revolution of the engine fuel is sprayed directly into the combustion chamber 3, through pulverizing nozzles fitted with automatic check valves, and ignition is obtained through the fuel impinging on the heated surface of the combustion chamber. The combined heat of compression and combustion sustains the temperature necessary for ignition, and consequently no blow lamps are required except for a few minutes before starting the engine. The various operations of the working cycle can be clearly understood from an inspection of the indicator diagrams taken from the cylinder and crank chamber and reproduced in Figs. 10 and 11, and the sequence and correlation of the operations will be appreciated. These diagrams show the excellent results obtainable by careful design based on extensive experience.

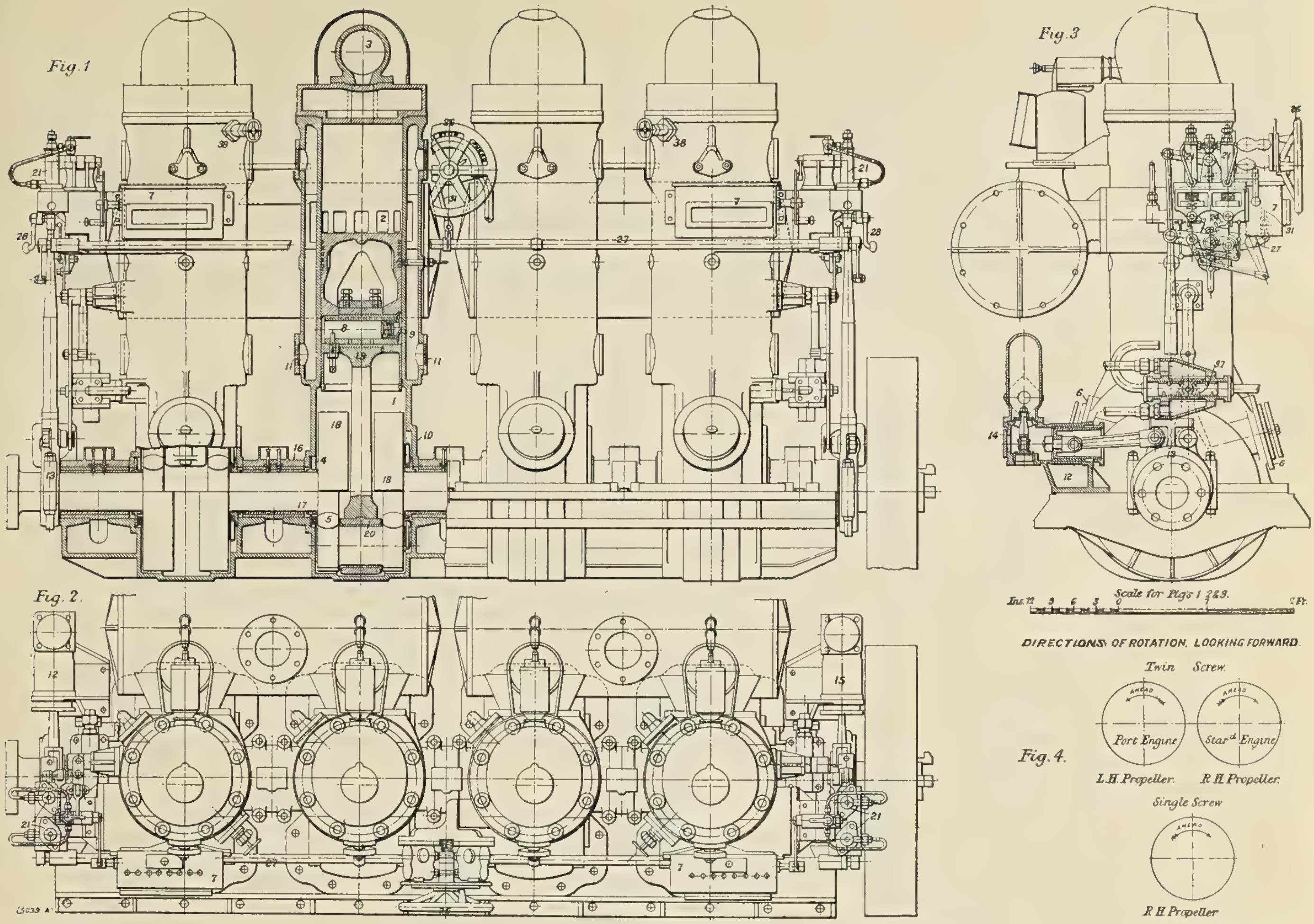
Scavenging

As already stated, scavenging air is compressed in the enclosed crank chamber, and in order to obtain the necessary quantity of air at a suitable pressure for efficient scavenging the volume of the crank chamber is reduced to a minimum and the whole is made as nearly as possible airtight. The latter condition is difficult to attain where the shaft passes through the walls of the crank chamber, and the method adopted on this engine is interesting. A bronze ring, 4, Fig. 1, is carefully bedded to the body of the shaft close to the crank-web, and is pressed against a machined surface on the inner side of the crank chamber by springs, 5, between the ring and crank-web. The ring revolves with the shaft, and consequently wear is confined to the flat surface and automatically corrected by the springs, which exert sufficient pressure to prevent the ring leaving its face when the air pressure in the crank chamber is below that of the atmosphere. Since inefficient scavenging is necessarily accompanied by loss of power and waste of fuel, the problem of rendering the crank chamber airtight is of the utmost importance and has received much attention from engineers, but perfect airtightness has not yet been achieved. Channels are therefore provided on this engine between the main-bearing cap and the side of the crank chamber to allow the free escape of any trifling leakage past the ring, and thus to prevent the possibility of interference with the lubrication of the main-bearing bush. Air is admitted to the crank chamber through grids at the front and back covered by flexible plate valves backed by light springs, and these are mounted on large doors, 6, Fig. 3, the removal of which gives easy access to the crank-pin bushes.

Lubrication

It will be obvious that with this enclosed type of crank chamber, which is utilized as a scavenger pump, forced lubrication cannot be applied to the crank-pin bearings, because a large quantity of the overflow would be taken up by the air and eventually find its way into the working cylinders, with the attendant result of excessive consumption of lubricant. The question of lubrication, therefore, is a difficult one, but has been solved in the "Beardmore" engine in a most satisfactory manner. A forced sight-feed system, with separate plunger pump and oil tube to each point where lubrication must be positive and regular, has been adopted, and by this means the quantity of lubricant supplied to any point is definitely controlled by the attendant, while any interruption of the supply due to a choked tube or faulty valve can be instantly detected and the sight glass shows clearly which point is affected. Two eight-feed lubricator boxes, 7, Figs. 1 to 3, are em-

* From *Engineering*.



Sections and Elevations of Beardmore Marine Semi-Diesel Engine

ployed on this four-cylinder engine, and the reciprocating drive is obtained from the fuel-pump actuating gear. The sixteen feeds are distributed as follows: three to each cylinder and one to each crank pin. The cylinder feeds are disposed in such a way as to lubricate the entire working surfaces of the piston and cylinder wall, while one feed also serves to lubricate the gudgeon pin. The gudgeon pin is hollow, as shown at 8, Fig. 1, and is secured in place by a screwed pin, which is split at the point to prevent the possibility of falling out. At the other end of the hollow gudgeon pin is a plunger with a scoop end, 9, Fig. 1, which is forced against the cylinder wall by means of a spring and collects oil from the lubricating tube already mentioned. The feed for the crank pin is carried through the side of the crank chamber and led to the interior of a revolving ring, 10, Fig. 1, from which the oil is carried by centrifugal force to its destination. The lubrication of the main bearings is effected by means of siphon tubes—an accepted marine practice.

Details of Construction

The cylinders are cast separately and are extended below the working barrels to form the upper halves of the crank chambers. The cylinder bodies are completely encircled by ample water jackets, and large access doors, 11, Fig. 1, are provided to facilitate the removal of any deposit which may be formed therein. The cylinder covers and silencers are also jacketed, and the circulating water is supplied by a reciprocating pump, 12, Figs. 2 and 3, placed at one end of the bed-plate and actuated by an eccentric, 13, Figs. 1 and 3, on the crankshaft. The pump body is of cast iron lined with brass and is provided with brass non-return suction and delivery valves, spring-loaded escape valve and a large cast iron air vessel. Access to the suction valve is obtained by removing door 14, Fig. 3, and to the delivery valve by removing the air vessel. A bilge pump, 15, Fig. 2, of the same size and design, is placed at the other end of the bedplate and similarly operated.

Bedplate and Crankshaft

The bedplate is cast in one piece, with suitable flanges for bolting down to the seating in the ship, and is provided with machined recesses to receive the main bearing bushes. The main bearing caps, 16, Fig. 1, are readily accessible for removal, and when removed the bushes, 17, Fig. 1, which are made eccentric to the shaft on their outer diameter, can easily be slipped from under the shaft without disturbing any gear whatever. The bushes are of Admiralty quality gun-metal with white metal lining.

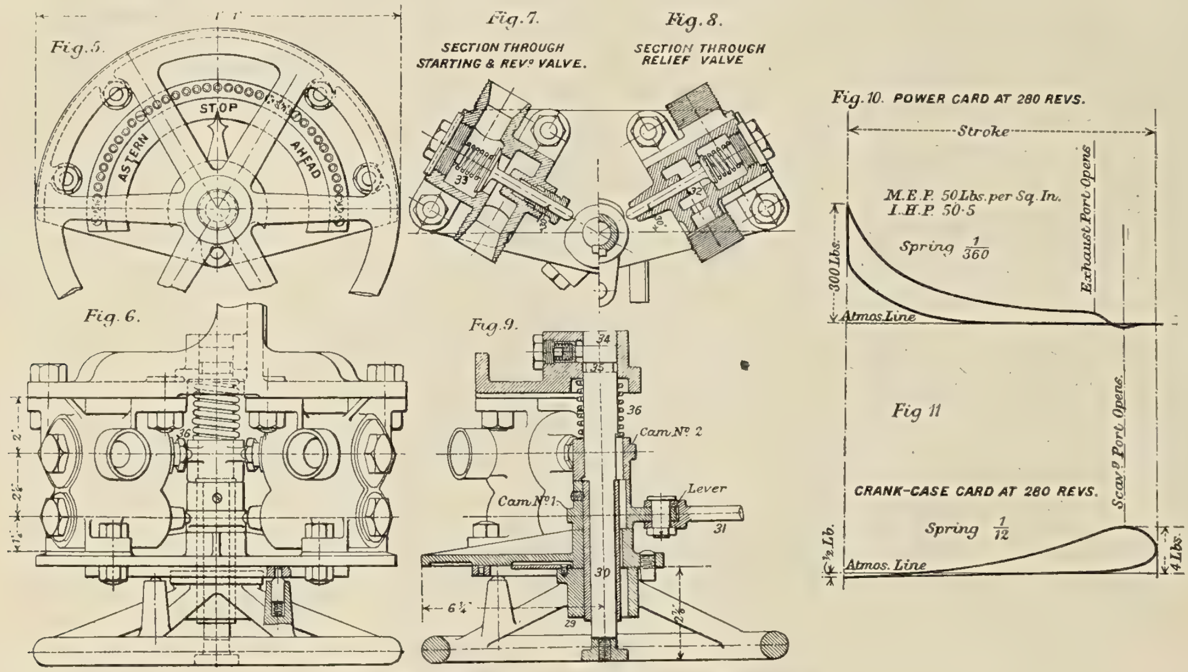
The crankshaft is a solid forging of Siemens-Martin steel, and is machined all over. Large balance-weights, 18, Fig. 1, are secured to the crank-webs, and these not only give to the engine an evenness of turning moment and a desirable freedom from vibration, but also serve to reduce the clearance volume of the crank chamber, and thus increase the scavenging efficiency.

The connecting rods are machined steel forgings fitted with adjustable bearings at top and bottom ends. The top end, 19, Fig. 1, of each rod is of special design to allow of easy adjustment, and the bearing surface is of phosphor-bronze. Examination of the gudgeon pin and bush, also piston and piston rings, is obtained by removing

the cylinder cover and drawing the piston upwards after the lower end of the connecting rod has been disconnected. The marine type crank pin bush, 20, Fig. 1, is of Admiralty quality gun-metal, with white metal lining, and is accessible for examination or adjustment through the doors, 6, Fig. 3, arranged at the front and the back of the crank chamber.

Fuel Pumps

The four fuel pumps, 21, Figs. 1 to 3, are grouped in pairs at opposite ends of the engine and are operated by the eccentrics, 13, Figs. 1 and 3, previously mentioned in connection with the water pumps, a horizontal rocking lever, 22, Fig. 3, fulcrumed at its center, being employed to carry the fuel-pump strikers, 23, Fig. 3. The stroke of the strikers is, of course, very much in excess of that to be communicated to the fuel pump plungers, and consequently the discharge of fuel to the combustion chambers is restricted to a very short period. The idle portion of the stroke is utilized for governing purposes, and as the action of one is identical with the others it will be sufficient to describe one. The pump striker is pivoted on the rocking lever and is free to rotate but for the action of a light spring, 24, Fig. 3, drawing it towards its guide. On the face of the guide a step is formed which throws the striker off its original course, but as this effect is counteracted by the spring already mentioned the engine speed determines whether the striker shall hit or miss the pump plunger. The tension of the spring can be adjusted to cut out at any engine speed, and when that adjustment has been made the following conditions are fulfilled: At all engine speeds up to and including a predetermined limit the fuel pump delivers a definite quantity of fuel during a definite fraction of each engine stroke, the quantity delivered being entirely under the control of the attendant on the starting platform, and when the engine speed exceeds the predetermined limit the pump automatically ceases to operate until the normal speed is regained. When it is remembered that all four fuel pumps are alike, it will be readily understood that the system of governing is very sensitive and quick in action, and it is worthy of note that the tension of the governor springs can be adjusted either individually or collectively while the engine is running. The maximum quantity of fuel to be delivered at full power is determined by a screwed collar, 25, Fig. 3, on the lower end of the pump plunger. By turning this collar to right or left the plunger is raised or lowered relatively to the striker, and consequently the stroke of the plunger is limited, but this adjustment, of course, is only required when tuning the engine to suit a given quality of fuel and should not be used for any other purpose. The ordinary control of the engine speed is effected through a hand wheel, 26, Figs. 1 to 3, placed at the center of the engine. The fuel pump strikers are mounted on eccentrics in the rocking lever, and these eccentrics are connected by a system of levers and links to a horizontal shaft, 27, Figs. 1 to 3, running along the front of the engine. Any rotary movement of this shaft is therefore transmitted to the eccentrics, and the strikers are thus raised or lowered collectively according to the direction of movement imparted to the horizontal shaft by the hand wheel. Very fine graduations of the engine speed are obtainable in this way. A priming handle, 28, Fig. 1, is fitted to each fuel pump for charging the pipes before starting, and any pump can be put out of action instantaneously by raising the handle to a horizontal position. Should it become necessary for a pump to be put out of action permanently the screwed collar already referred to in connection with tuning meets this requirement, and when thus cut out the suction and delivery valves and springs can be removed for examination by simply disconnecting the delivery pipe and screwing out the plug in the top of the pump barrel.



Details of Main Valves and Indicator Diagrams

Starting and Reversing

Starting and reversing are effected by means of compressed air and the details of the gear, Figs. 5 to 9, show how all the operations of the engine are controlled by a single hand wheel. The hand wheel is mounted on a sleeve, 29, Fig. 9, which also carries a lever and cam No. 1 (Fig. 9), while a central spindle, 30, passing through the sleeve, carries cam No. 2 (Fig. 9). The lever is connected by a link, 31, Figs. 1, 3 and 9, to the fuel pump controlling shaft, 27, Figs. 1 to 3, the cam No. 1 opens one of the two relief valves, 32, Fig. 8, and the cam No. 2 opens one of the two high pressure air valves, 33, Fig. 7. The

air valves are directly connected with the compressed air reservoirs, Figs. 12 and 14, on the one side and with mechanically operated distributing valves on the other side.

It will now be understood that when the hand wheel is turned clockwise the cam No. 2 opens the air valve on the left and admits compressed air to the ahead distributing valves, the cam No. 1 opens the relief valve on the right and places the astern distributing valves in communication with the atmosphere, while the lever brings the fuel pumps into action. The engine then starts on compressed air, but, as the fuel pumps operate immediately the engine starts, the air connection can be closed on the completion of one revolution. The latter is the function of the central spindle which carries cam No. 2. By pushing the central spindle towards the back, the air valve spindle drops off the cam and a spring plunger, 34, Fig. 9, entering a groove, 35, Fig. 9, in the central spindle, locks it in the new position. The hand wheel can now be used to regulate the speed of the engine without having any effect on the closed air valves, but whenever the wheel is placed in the stop position the central spindle is automatically released and is returned by a spring, 36, Fig. 9, to its original position in readiness for a fresh start in either direction. A start in the astern direction is effected by turning the hand wheel anti-clockwise, and thus placing the astern distributing valves in communication with the compressed air reservoirs and opening the ahead distributing valves to the atmosphere. Moving the hand wheel in either direction from the stop position brings the fuel pumps into action, and it is noteworthy that the driver's attention is confined to two simple operations, viz.: turning the hand wheel in the proper direction and pushing the central spindle when the engine has started. The air distributing valves, 37, Fig. 3, are actuated by the eccentrics provided for operating the water and fuel pumps, but are brought into operation only when compressed air is admitted to them, and consequently there is no wear and tear of the reversing mechanism while the engine is running. It is an admirable feature of this gear that no part of it is in motion except for a few seconds during each start or reverse of the engine, and it is therefore an easy matter to withdraw valves and other parts for examination or overhaul while the engine is at work.

Two of the engine cylinders are fitted with spring-loaded, non-return valves, 38, Fig. 1, through which the air reservoirs can be charged while the engine is running. A sufficient supply can be maintained in this way for all ordinary purposes, but an independent power-driven air compressor is supplied to meet the requirements of excessive maneuvering and to renew the supply should it be lost from any cause.

In the case of a 160 brake horsepower "Beardmore" engine installed in a typical British coaster, 75 feet long between perpendiculars, 18 feet beam, and 8 feet 6 inches draft, the weight of the complete installation, including fuel tanks, floor plates, pipes and connections, is 14 tons, and the engine-room bulkheads are 15 feet apart.

Development of Machinery in the United States Navy During the Past Ten Years*

Oil Fuel Adopted Exclusively on First Line Ships—Performance of Oklahoma Class Battleships—Advantages of Electric Drive

BY REAR-ADMIRAL C. W. DYSON, U. S. NAVY

As the developments of battleship machinery for the next two programmes were intimately connected, these two programmes will be discussed together, so far as main propelling engines and provision for cruising economy are concerned.

Taking up another very important change at first we will turn to the question of fuel. Experience with oil fuel on the destroyers having been so highly satisfactory, after thoroughly going over the question the Navy Department decided to fit the future vessels of the first line to burn oil fuel exclusively. The reasons governing this decision are:

1. Ease in regulating steam supply.
2. Less wear and tear on the boilers.
3. Increased boiler efficiency.
4. Maintenance of boiler efficiency.
5. Decreased complement of men.
6. Less manual labor required in operation and maintenance.
7. Greater regularity in steam pressures.
8. Less hull deterioration from corrosion.
9. Greater ease and less interference with routine of ship, in and while refueling.
10. Decrease in fuel weight for given cruising radius.
11. Decrease in total bunker capacity.
12. Ability to use otherwise waste spaces for carrying fuel.
13. Ease with which fuel can be delivered to the boilers.

In opposition to these advantages there are only two disadvantages:

1. Greater cost of fuel, due to possible limited supply to meet all demands, commercial as well as naval.
2. Less general distribution of oil over the globe, necessitating the transportation of fuel to distant points where oil fuel may not be available.

The advantages to be gained far outweighing the disadvantages, the step was taken and oil fuel was adopted. Other nations have claimed the honor of having led in this path, but their claims are not justified. Our *Oklahoma* and *Nevada* were the first sea-going battleships ever designed for the use of oil as the sole fuel.

When this determination was made it was determined to specify boilers of the large tube express type that is, generally similar in design to destroyer boilers except the diameter of the tubes, which was increased from 1⅛ inches and 1¼ inches up to 1⅝ inches, as the Babcock & Wilcox boiler was designed, and which had been practically adopted as the standard battleship boiler, was not considered suitable for oil fuel work on account of the low angle of the tubes, which was only fifteen degrees from the horizontal, and on account of the metallic side water walls of the furnace.

* Reprint from the Journal of the American Society of Naval Engineers, continued from January, 1918, issue.

Having so decided, superheaters, while very desirable, were omitted, as experience has demonstrated that superheaters fitted in uptakes outside the boiler lack durability, their deterioration being much more rapid than that of the boiler.

Babcock & Wilcox Boiler Redesigned

The *Nevada* was built with this type of boiler, the Yarrow. The Babcock & Wilcox Company had, however, in the meantime given way to the wishes of the Bureau of Steam Engineering and had redesigned their boiler, replacing the water walls of the furnace with fire brick, increasing the angle of the two lower rows of tubes next the furnace, which were 2 inches in place of one row of 4-inch tubes, and which absorb the maximum amount of heat, to 20 degrees, while the remainder of the tubes were angled at 18 degrees. In addition, the boilers were fitted with downcomer pipes from the ends of the steam drums to the outer ends of the front cross boxes.

After these changes in design were made the Bureau felt assured of the success of the new boiler, and when the contractors for the *Oklahoma* proposed its installation in that vessel, favorable action was recommended to the Navy Department and the new type was installed.

During the preceding few months a plant for testing out boilers under oil fuel, for experimenting in oil fuel burning and for instructing men in the art of oil fuel burning, had been erected at the Navy Yard, Philadelphia. In this plant had originally been installed two boilers, Normand and Yarrow, of the large tube battleship type, and the first boiler of the *Oklahoma* type to be completed was purchased and installed in the plant. Comparative tests of the three boilers showed that the Babcock & Wilcox possessed a marked superiority in economy over the Yarrow, while the Yarrow was somewhat superior to the Normand.

Propelling Machinery of Oklahoma Class Battleships

The propelling machinery shown and specified was of the reciprocating engine type, fitted with forced lubrication and with two condensers per engine, one located at each end of the engine with a short, large diameter connection to the adjacent low pressure cylinder. These exhaust connections were fitted with accordion joints to care for expansion and vibration, and with gate valves by which the condenser could be cut off from its cylinder. In each L. P. receiver pipe was fitted a gate valve by which, in case of a badly leaking condenser or disarrangement of a L. P. cylinder, the cylinder involved should be cut out and the engine run as a three-cylinder triple, at reduced power. Each condenser had its own air pump and circulating pump. The air pump channel ways were all cross-connected in order that any number of the pumps could be used as desired. The two circulating pumps at the same engine ends had their suctions cross-connected. This enabled suction to be taken from either side of the ship in case of grounding. It also permitted suction of one pump to be taken through the condenser on the opposite side of the vessel, using the outboard delivery of that condenser as a main injection. In fact, every possible measure was taken to render the ship immune from breakdown.

While the designs were being prepared the Fore River Shipbuilding Company appeared on the scene with a proposed layout of turbine machinery consisting of a high and a low pressure turbine on each shaft, there being two shafts, and with the revolutions decreased from the 280 of the *North Dakota* to 200. An estimate of this proposed installation being prepared by the Bureau, it was found that it would require approximately the same shaft horsepower for the different speeds as the indicated horsepower for the same speeds of the reciprocating engine ship. This was a large reduction in power as compared with previous turbine-driven vessels, and the Bureau recommended that this plan be accepted, requiring, however, that additional changes be made to give better economy at cruising speeds and securing the guarantees by abnormally heavy penalties. The means provided to obtain this economy a cross-connection was to be provided between the exhaust pipes of the high pressure turbines on the two shafts in order that, at reduced powers, steam could be taken in the high pressure turbine on one shaft and exhausted into the L. P. turbine on the other, the other two turbines running in vacua. This doubled the amount of steam flow through each active turbine and so held up the economy. This fitting was never installed, however, as a much better scheme was developed with the next year's battleships.

The contracts as carried out provided one battleship, the *Oklahoma*, with reciprocating engines and Babcock & Wilcox boilers, and one battleship, the *Nevada*, with compound Curtis turbines on two shafts, with turbines and reduction gear for cruising. Neither vessel was fitted with superheaters.

Change in Cruising Engines

The change in the cruising apparatus came about through action taken on the design of propelling engines for the battleships next appropriated for, the *Pennsylvania* and *Arizona*.

During the preparation of plans for these two vessels, the Bureau of Steam Engineering was approached and inquiries made as to whether turbine installations would be considered. The inquirers were told that if turbine installations promising an equal or nearly as low a fuel expenditure as the reciprocating engines shown in the Department plans, preference would be given to the turbine installation.

To meet this requirement the Curtis turbine advocates presented a plan having four shafts with high pressure turbines on two inboard shafts and low pressure turbines on the two outboard shafts. The Bureau informed them that if cruising turbines with reduction gear were fitted to the low pressure shafts, exhausting to the main H. P. turbines, the installation would be approved. This change was made and one vessel, the *Pennsylvania*, was fitted with Curtis turbines designed for 220 revolutions per minute, and the other vessel, the *Arizona*, with Parsons turbines of 240 revolutions per minute, both of them being fitted with cruising turbines and reduction gear for economy at low speeds. These vessels were the first battleships ever laid down by any nation with this arrangement for cruising economy. Before the *Nevada* was completed the contractors, evidently fearing that the guaranteed cruising economies could not be realized, proposed to the Department that the means for obtaining this economy originally proposed be abandoned and that cruising turbines and reduction gear installed on each shaft forward of the main turbines be substituted. This change was approved and the machinery so built. The *Nevada's* turbines marked a further advance for this type in that the old form of disk diaphragms between stages was abandoned; diaphragms split on the horizontal diameter being fitted. The turbines as fitted on the *Pennsylvania* also marked a still further advance, the high pressure turbines in this vessel being of the so-called "reverse flow" type, which means that after the steam had passed partially through the turbine, a portion of it was by-passed to the after end of the turbine and flowed forward, thus reducing the

steam thrust and also, if so desired in the design, decreasing the lengths of the blades.

The economy results obtained with the three vessels which have been tried up to date, the *Nevada, Oklahoma*, and *Pennsylvania,* have been very satisfactory and all expectations have been met. The low power results with the last named ship may even be classed as remarkable.

Economy of Oklahoma Class

Taking the *Oklahoma's* fuel consumptions as 100 percent, the fuel expenditures were as the following percentages:

Speeds	10	15	19	20.5
Oklahoma, percent	100.	100.	100.	100.
Nevada, percent	88.9	88.6	99.8	101.2
Pennsylvania, percent	91.5	103.6	101.4	101.6

This shows that the *Pennsylvania,* while over 3,000 tons heavier than the *Oklahoma* and *Nevada,* on the trials consumed very little more fuel than the reciprocating engined ship.

These results marked the passing of the reciprocating engine for battleship propulsion, and the succeeding two vessels, the *Mississippi* and *Idaho,* were practically duplications of the machinery of the *Pennsylvania* and *Arizona.*

Destroyer Tenders

During this same period the Department contracted for and there were constructed a destroyer tender, the *Melville,* fitted with Westinghouse reduction gear, consisting of H. P. and L. P. turbines driving two pinion shafts with pinions meshing into a gear wheel on the single main shaft, and a submarine tender, the *Bushnell,* with Parsons reduction gear, similarly fitted. The latter vessel had, however, one innovation, and that was in the means taken to drive the generators for providing current to charge the submarine batteries. These generators were two in number, one located directly forward and in line with each turbine shaft, to which they were attached by means of loose couplings, similar couplings also being fitted between the turbines and reduction gears. By this means both the main turbines could be used for driving the generators in port, while when under way either turbine could be used for driving the main propelling shaft while the other operated one of the generators, or both generators could be cut out and both turbines used to propel the vessel. During this same period plans were purchased for Diesel engines of 2,500 shaft horsepower, and work started on the construction of two of these engines for the fuel ship *Maumee.* These engines have been completed and the vessel is now in service. The *Maumee's* engines represent the maximum power installed in any one ship up to the present time. All three of the above installations have been satisfactory in operation and undoubtedly mark the passing of the reciprocating steam engine from the field of auxiliary vessels.

The forced draft blowers on the *Oklahoma* and *Nevada* are driven by electric motors, but trials have demonstrated that there is not sufficiently close regulation of air supply for efficient oil burning with this type of drive, having its speed regulation stepped. These blowers are to be replaced with steam turbine-driven ones similar to those on the later vessels.

Electric Propulsion

The next advance in propulsion of capital ships occurred when the Department decided to fit the *New Mexico* with electric propelling machinery. This decision was the result of the unqualified success of this type of machinery on the *Jupiter.* This decision has since been adhered to and there are at present seven battleships and four battle cruisers building with such machinery.

The advantages of electric machinery for such classes of vessels are:

1. Greatly increased torpedo protection for ships.
2. Greater flexibility in machinery arrangement.
3. Better and wider separation of important units.
4. Minimum lengths and diameters of steam pipes.
5. Fewer bulkheads pierced by steam and feed piping.
6. Reduced heating of vessel from steam pipes.
7. Better centralization of power.
8. Reduced engine room complement.
9. Elimination of danger from fractures of piping due to shells striking protective deck.
10. Greater ease in control.
11. Greater flexibility in power distribution.
12. Better maintenance of economy through a wide range of powers.
13. No metallic contact between rotor and stator of motor.
14. Eliminating all dangers of disarrangement due to shaft vibration when the helm is put hard over.
15. Maximum reduction in length of shafting.
16. Increased backing power.

In opposition to these claims can only be advanced one, that of greater weight. This can be discounted on the heavy ships where protection is of vital importance. On the light, fast vessels, such as destroyers and scouts, where no protection exists, everything is sacrificed for speed, and for such vessels the mechanical reduction gear stands pre-eminent to-day.

Conclusion

In the course of this paper I have taken you through power development from 16,500 indicated horsepower to 60,000 shaft horsepower for battleships, from 25,000 indicated horsepower for armored cruisers to 180,000 for battle cruisers, and from 7,500 indicated horsepower to 28,000 shaft horsepower for destroyers. Also I have shown you the reciprocating engine reaching its maximum efficiency and disappear, to be replaced by the turbine drive with and without cruising units. This again, when highly successful, has bowed its head and moved aside that the straight mechanical or electrical reduction gear might take its place. The end has not yet been reached, but probably changes from now on will be slow and no decidedly new type will usurp the places of those now in use for years to come. The future is in the hands of the young men of the Service, and every confidence is felt that they will not lag behind in taking their share of the burden in the development of the marine machinery of the future.

American Foreign Trade in September.—American exports in September totaled $456,201,567 (£93,500,000), according to a statement just issued by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce. This is a decrease of approximately $34,000,000 (£7,000,000) compared with August, but a gain of $80,000,000 (£16,400,000) as compared with July. For the nine months ended with September the total exports were $4,607,817,178 (£945,000,000), a gain of $657,000,000 (£135,000,000) over the similar period in 1916.

Imports in September also fell off, the total being $236,196,898 (£48,600,000), as compared with $270,509,379 (£55,500,000) in August. The total imports for the nine months ended with September were $2,282,794,503 (£470,000,000), a gain of $450,000,000 (£92,400,000) over the corresponding nine months in 1916.

Transportation Efficiency for the War

What New Orleans Has Accomplished and What New York Can Learn From It—Development of Terminal Facilities

BY E. AMBERG

CONGESTION of traffic is a serious handicap at all times, but at present it is particularly vital to our successful prosecution of the war. Owing to the vast growth of business caused largely by the European war, the freight traffic on American railroads and at steamship terminals has been greatly increased, with the result that facilities for handling past quantities of freight naturally are inadequate for handling the present increased amount. Terminal reorganization and more freight handling facilities are the propelling factors in solving the present problem. Not ten years ago James J. Hill predicted the breakdown of our railroads unless terminals were revolutionized.

New York, the first port of the United States, acts as a depot of distribution for the products of numerous industries of America. Fifty percent of the foreign trade of the United States passes through the port of New York. Thus delays in delivering freight and consequent excessive costs in New York not only affect the port locally, but influence the industry and commerce of the whole country as well.

The people of the South have long been reputed as a dreaming, easy-going lot, but visit the city of New Orleans now and see for yourself what strides industry has taken there and what a far-seeing people guard its commercial interests. Preparedness has been their watchword. The course of events pointed the way to the expansion of foreign trade, and New Orleans began to develop her port equipment with that end in view long before the expansion was here.

New Orleans has a marvelous physical situation—only 110 miles from the Gulf of Mexico, with accessibility to Eastern commerce, with an open door to the trade of the West through the Panama Canal, and with the Mississippi River encircling the city for 41½ miles, providing a trade route of least resistance.

But where is New York's physical lack? It has its own harbor leading to the Atlantic, and a water frontage of 928 miles, with the Hudson River on one side and the East River on the other.

However, development does not rest alone on physical structure; it depends also upon financial and administrative features. New Orleans has been wise in preserving her water front as a public heritage (as far back as the treaty of Louisiana) and by creating and operating a municipally owned switching Belt Line.

New Orleans Water Front a Public Heritage

Only a small fraction of her water front (less than 3 miles of the 41) is controlled by the railroads, and this water front is subject to expropriation by the State at any time. The public docks are governed and operated by a State board with entire control of the water front and with the broad power "to do any reasonable and practical thing to increase the efficiency and economy of the port's facilities." The Dock Board handles 83 percent of the port's business.

Prior to the development of the docks the city leased the wharves to private corporations, but, on account of the poor structure of the wharves, insufficient machinery for handling freight and too high assessment of charges, this proved unsuccessful as a public utility.

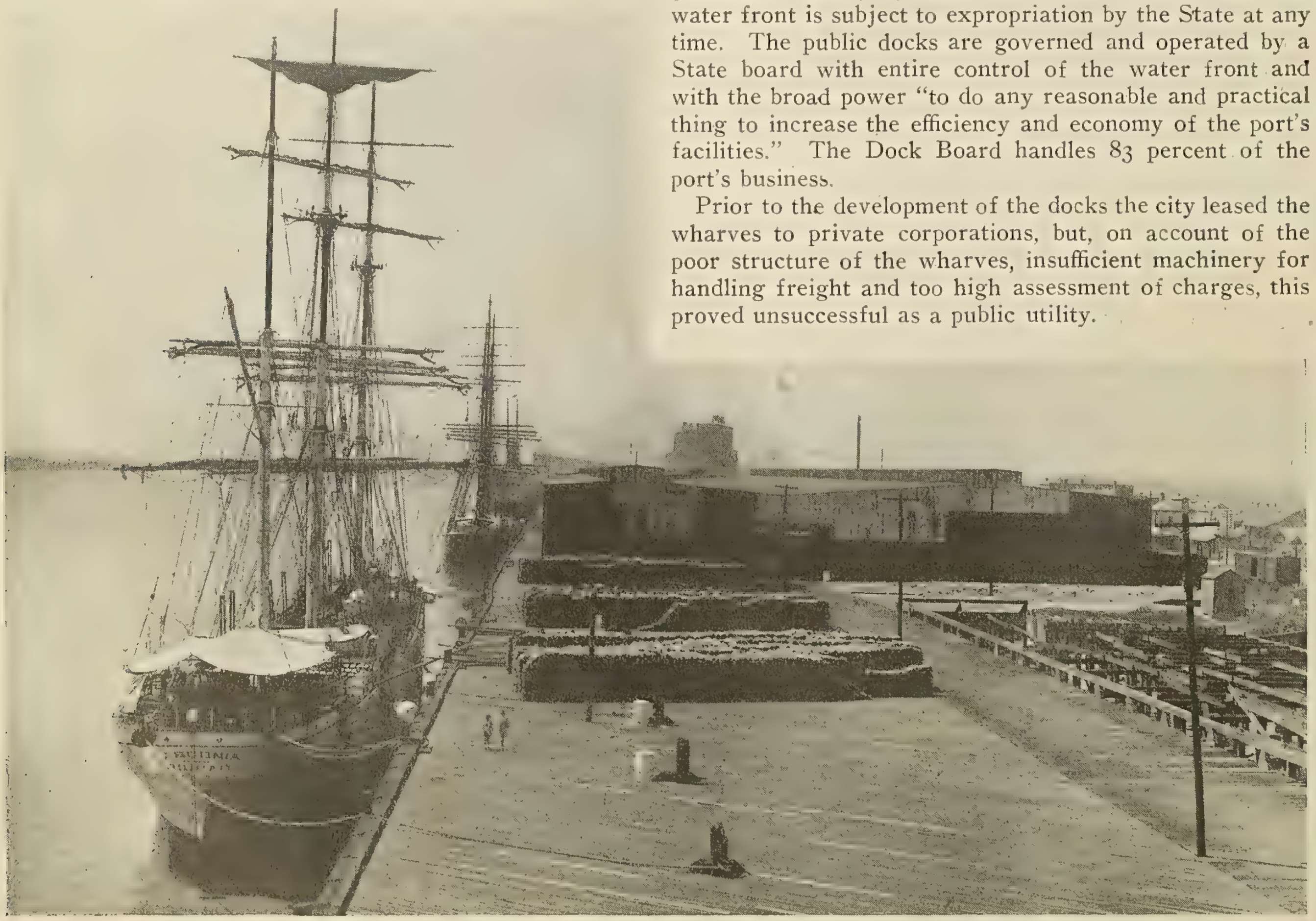


Fig. 1.—Typical Landing at New Orleans Water Front

Fig. 2.—Barges and Stern-Wheel Steamboats, Characteristic River Craft at New Orleans

The Dock Board has constructed permanent wharves of creosoted material and protected them by steel sheds. It has, furthermore, devoted itself to developing mechanical devices for expediting the movement of freight. Bananas are an important import of New Orleans. Formerly bunches were conveyed from the holds of ships by tackles and passed along by hand to the cars. Now the banana conveyor is used. It consists of a moving canvas belt drawn over iron frame-work, and—traveling on rails on the docks—can reach right into the hold of any ship. Each conveyor unloads about 2,500 bunches an hour, the average boat taking three conveyors (very often four), making a minimum of 7,500 bunches an hour and a maximum of 10,000 per hour. With former methods the maximum per hatch was 800 bunches per hour, 2,400 on a three-hatch vessel and 3,200 as a maximum.

The Dock Board's chief accomplishments, however, are a tremendous cotton warehouse and a huge grain elevator, the first costing $3,500,000 (£717,500) to construct, and the latter $2,000,000 (£410,000), both of which were financed through bond issues granted by the State. The board has an appreciable surplus from its 1917 revenues,

Fig. 3.—Transferring Freight from Warehouse to Hold of Sea-Going Vessel

with which it plans to build a large commodity warehouse. The warehouse and the elevator are not entirely completed, but handle a large amount of consigned freight at present. These two public facilities are adjacent, cover 100 acres of ground together, and will operate in conjunction with each other in such a manner as to permit ships to be loaded with cotton and grain simultaneously.

Both buildings are constructed of reinforced concrete, and the cotton warehouse is built in units to prevent the spread of fire, thus producing a considerable reduction in the fire insurance rate. The present charge for insuring grain at the port of New Orleans is 15 cents (0/7½) per $100 (£20.5), as opposed to a former charge of $1.65 (6/10½) per $100 (£20.5), and cotton insures for 0.31 percent per bale, while the former rate was as high as 1¼ percent per bale.

The cotton warehouse affords shipside storage, carrying surplus supplies of cotton subject to instant use of all consuming markets. Cotton designated for consumers in America and passing to foreign ports involves the charge of conveying to Europe and that of carrying it back again. Cotton held in storage at New Orleans can, whenever needed, pass to consumers in America or Europe under economic conditions.

The warehouse is a two-story building, all incoming freight is handled on ground floor and all outgoing freight on the upper floor. All phases of handling and storing cotton are provided for. The press room is provided with high density presses and faces north for the purpose of supplying the best light for testing samples. Overhead traveling cranes running in any direction pick up two bales at a time, involve the labor of only two men and save a great deal of time in piling. Electric tractors convey the bales on runways that encircle the building to any part of it. The bale-puller is another efficient device. It connects with the crane and by means of two steel arms which run in over the designated bale to keep off the strain of the rest of the pile, and by manipulation of a steel hook it neatly pulls out any individual bale of cotton without disturbing the rest of the pile at all.

The present capacity of the warehouse is 209,000 bales, and it will hold 500,000 when it is finished.

The grain elevator is 208 feet high. It holds 1,200,000 bushels of grain, and the annex which is under construction will hold 1,600,000 more. Grain is taken from the cars at the rate of 200,000 bushels per hour, is carried into elevators, conveyed by them to the top of the building, where it is weighed, then dropped into huge bins and sent from thence through chutes and innumerable belts to the holds of ships as fast as 100,000 bushels per hour. The equipment for taking grain from barges consists of great pneumatic suction pipes.

The entire elevator is run automatically by a system of light and gongs, thus resulting in minimum labor usage, 35 to 40 men constituting the entire working crew.

The Public Belt Railroad has been another fundamental factor in the development of New Orleans as a world port. This Belt Line is a publicly owned and operated facility. It provides non-discriminatory switching service to 11 trunk lines entering the city and 70 industries, manufactories and warehouses. It has the sole switching rights of New Orleans, and this, together with the fact that the line is municipally owned, makes a low, uniform switching cost easily understandable.

The charge for the switching service is $2 (8/8) per car, as opposed to a former charge of from $8 (1/13/8) to $13 (2/14/4) per car previous to the construction of the Public Belt in New Orleans. In the city of New York the costs to the railroads alone for delivering freight from New Jersey Meadows to New York City is $1.80 (7/6) per ton, and $25 (£5.1) to deliver a 20-ton car.

The services of the Public Belt are free to all users of the line in that all railroads absorb the switching charges on competitive business which exceeds 90 percent of the business handled by the Belt Line.

There is no doubt of the necessity for expediting the freight movement of the port of New York. New Orleans has already developed her port along efficient and economic lines; her facilities are available impartially for all shippers and receivers, and counteract the competition of rival railroads. This successfully worked out scheme points the way for New York; and when once the benefits are reaped from terminal improvements they will not be considered as merely temporary structures for war-time expediency, but will prove their value to the industrial and commercial future of the United States.

The Great Floating Cranes at Panama

Main Particulars of 250-Ton Floating Cranes Built in Germany for the Panama Canal

BY FRANK A. STANLEY

THE gigantic floating cranes, *Hercules* and *Ajax*, constructed for the Panama Canal, constitute two of the most important pieces of equipment in the great array of mechanical apparatus to be seen on the Canal Zone. They were built as part of the necessary equipment of the completed canal for handling gates of locks and docks, for handling unusually heavy pieces of freight, big guns and other material, and for service in connection with the repairing of ships, wrecking, etc. They are each capable of lifting loads up to 250 tons.

The two cranes were built in Germany and towed across the ocean to the canal; that is, the pontoons, with their fixed towers, power plants, and revolving superstructure, were towed bodily to the Isthmus, and the jib and certain other elements which had been shipped in "knock down" condition, were then erected in place.

Dimensions and Capacities

A general view of the *Hercules* (the cranes are alike in all respects) is shown in Fig. 2. The appearance of the crane in the canal, surrounded by other floating equipment, is well brought out by Fig. 1. Some general dimensions of importance, as showing the great size of the crane, are given in the following: The pontoon is approximately 150 feet long by 89 in breadth, while the top of the jib when in its innermost position is 206 feet above the pontoon. The counterweight under the operator's cab weighs 150 tons. There is another counterweight of 450

Fig. 1.—The *Hercules* in Operation at Culebra Cut

The crane, with a capacity for lifting loads up to 250 tons, is mounted on a pontoon approximately 150 feet long by 89 feet beam, while the top of the jib when in its innermost position is 206 feet above the pontoon. Three counterweights are fitted, one of 450 tons in the after end of the pontoon; a second of 150 tons under the operator's cab, and a third on the crosshead. All motions and hoists are operated by means of electric motors supplied with current generated by a steam plant, situated below decks in the after portion of the pontoon.

Fig. 2.—General View of Floating Crane *Hercules*, Showing the Two Hoists. The Main Hoist Is Designed for 250-Ton Loads and the Auxiliary Hoist for 15-Ton Loads

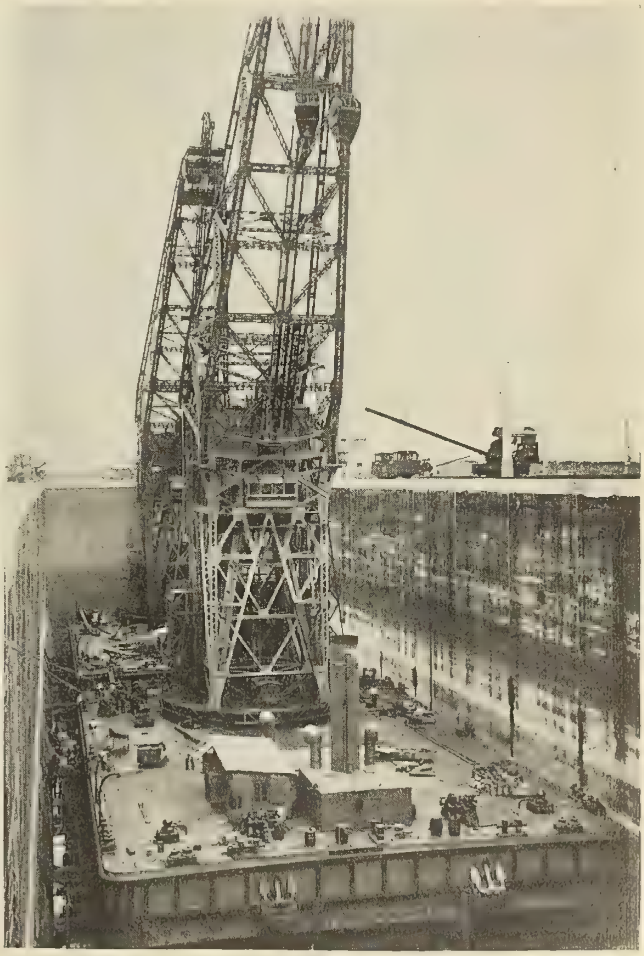


Fig. 3.—The *Hercules* and *Ajax* Dry-Docked in Gatun Lock of Panama Canal. The Cranes Occupy Only One-Third the Length of Lock Chamber

tons in the after end of the pontoon, and a third on the cross head.

All motions and hoists are by means of electric motors which operate the shafts, gears and drums, 220-volt current being generated by a steam plant situated below decks in the after portion of the pontoon. The pontoon itself is not self-propelling.

Near the center of the pontoon the deck is made extra strong. This portion, extending over an area 20 by 60 feet, is designed to carry loads up to 2,000 pounds per square foot and is intended to receive deck loads of 300 tons, so that when necessary the crane can carry very heavy loads on its deck and thus dispense with the use of barges.

Block and Hoist Details

There are two blocks on the main hoist, each of which is carried in ten parts of 2-inch steel cable. The block and guide sheaves are 63 inches in diameter—that is, over 5 feet across. The blocks measure over all 9 feet in height by 6 feet in width, and are built up of steel plates and angles. To one unaccustomed to anything but the very heaviest of engineering work these blocks, which actually form but a small detail of the giant crane, are most interesting objects, and the same may be said of the triangular "hook" which is used with an equalizing bar when the two main hoists are operated together, this hook having a capacity of 250 tons.

The auxiliary hoist, which is equipped with a double barbed hook, has a rated capacity of 15 tons and the hook is, of course, designed for that load with a reasonable excess under test conditions.

The Cranes in Dry Dock

A striking view of the two cranes drydocked in the upper chamber of the east flight of locks at Gatun is shown in Fig. 3. This engraving brings to attention at once the immense proportions of the *Hercules* and *Ajax* and the capacity of the locks themselves, which enable the two cranes to be so readily docked. Bulky as they are, the cranes occupy less than one-fourth the space available in the lock chamber, for the latter has a length of 1,000 feet and a breadth of 110 feet, so that the two pontoons, with their combined lengths totaling over 300 feet require for docking less than one-third the length of the lock chamber and on either side of the pontoons is left a 10-foot clearance space between cranes and walls.

Watertight Doors*

System of Doors Giving Communication to Compartments Without Impairing Watertightness

BY ENG.-LIEUT. I. TORO †

THE introduction of watertight doors for ships was a necessity which arose when watertight bulkheads came to be fitted, in order to give ready access to compartments which contained the machinery, or other compartments to which it was deemed desirable to get access periodically for inspection, and yet have efficient means readily available to isolate these in emergency.

The necessity demanded the invention of a system which could be readily available when the moment arrived to close the doors. Several plans have been invented for the purpose, and yet there appears room for more—hence that which is now submitted for discussion.

The object of this system of watertight doors is to allow of easy communication from one compartment to another, also to provide means of escape from one compartment to an adjoining compartment without allowing the watertightness of the bulkhead to be impaired.

Construction of Air-Tight Chamber

In this system an opening is cut in the bulkhead, and to this opening is fitted, in a water- and air-tight manner, a chamber or cell of rectangular or other suitable shape; this cell is formed by two rigid cast steel frames of the required dimensions, to enable one or more men to move about in the cell. This chamber has two openings, one at each side, through which men can pass, and each of these openings is fitted with a sliding door (*EE*) adapted to slide in ways to and from the seat, so that, when open, there is a clear entrance into the chamber, or, when closed, a wedge-shaped edge on the door enters between correspondingly shaped faces or into a recess in the seat or sill of the opening, thus forming a watertight joint to prevent leakage and render the door self-packing. In the diagrammatic sketch reproduced these doors are operated hydraulically, but they could also be worked pneumatically, electrically or otherwise, in such a way that under no circumstances whatever can both be opened at the same time, one door remaining open when the other is closed, and *vice versa*, or both remaining closed.

Operating Gear

As the gear for operating both doors is similar, in the following description we shall refer to one door only, except where the gear of one door interferes with that of the other. A convenient method of operating the doors is by means of a rack or racks on each door operated by pinions keyed on a shaft. In the case of hydraulic power being used, a hydraulic cylinder *A* is provided fitted with a piston whose piston rod has a rack *B* gearing with a pinion *C* keyed on a shaft which has another pinion *D* gearing with a rack on the door *E*, so that by admitting pressure to one side of the piston in the cylinder and putting the other side to exhaust, the door is opened or shut according to the direction in which the pressure acts. In the sketch, pressure to open the door should be admitted at the top end of the cylinder.

Controlling Valves

The controlling valve for the hydraulic cylinders can be operated from the inside of the chamber or cell by means of a pair of hand levers, or from the outside of the chamber by similar levers, the said levers being adapted to control ordinarily the respective doors. The working lever *T* is of the bell crank type, and is connected to the lower end of the spindle of the controlling valve *F*. The doors are so arranged that one must be completely closed before the other can be opened. To fulfil this condition, certain

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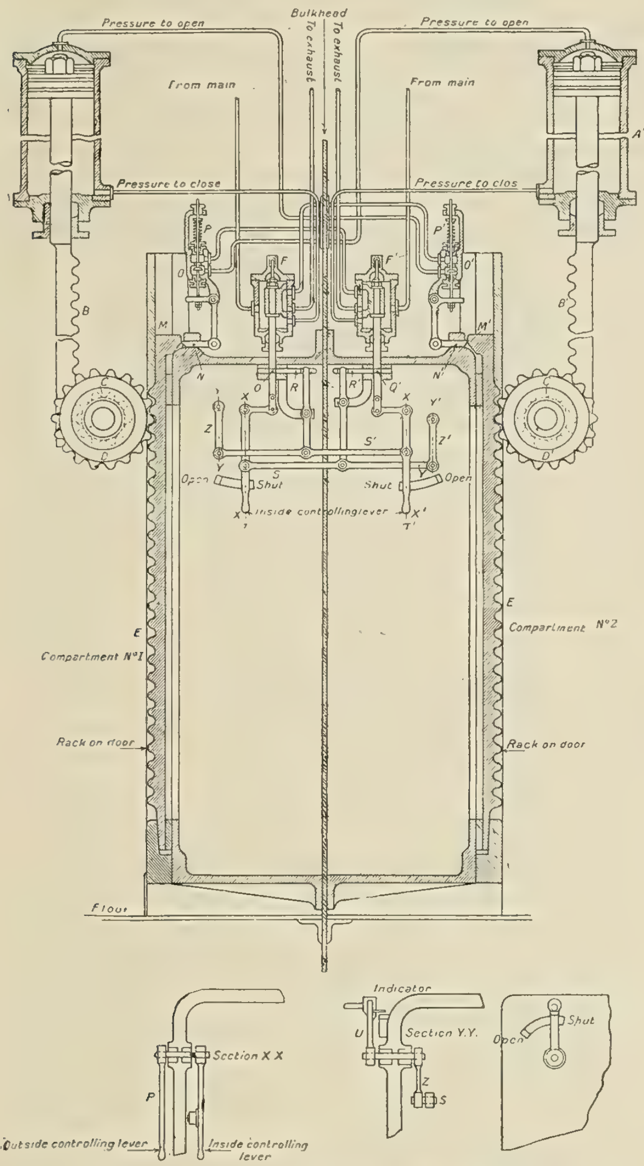
* Paper read before the Institute of Marine Engineers, London, September, 1917.

† Chilian Navy.

appliances, which vary according to the gear used to operate the doors, are provided; in the case of hydraulically operated doors, an intercepting valve O in connection with each door is provided, this valve being worked by the door in such a manner that when one door is opened, fluid pressure to open the other door cannot reach the hydraulic cylinder.

The intercepting valve O may, if desired, be fitted in the top of the chamber, its spindle being connected to a bell crank lever N, one of whose arms is operated by a cam M fitted on the top of the door in the rear, and so



Diagrammatic Sketch of Door and Controlling Mechanism

arranged that only when the door is perfectly closed the cam M would move the spindle of the valve O to allow a free passage between the controlling valve and the opening end of the cylinder actuating the other door. The chambers of the intercepting valve O are connected respectively by pipes with the hydraulic cylinder that operates the other door, and with a port in the chest of the controlling valve that operates the said hydraulic cylinder, so that the pressure fluid, on being admitted by the controlling valves, passes through the pipes by way of the intercepting valve of one door to the hydraulic cylinder of the other door. The chambers of the intercepting valve of the opposite door are similarly connected, so that the opening of one door keeps the other closed, and *vice versa.* If, therefore, one of the doors be opened, the act of opening will release its intercepting valve spindle, so that such intercepting valve closes by the pressure of the spring P and cuts off any admission of pressure fluid into the hydraulic cylinder of the other door. It will be seen, therefore, that if one door be open and the other closed, the operation of the lever to open the closed door would have no effect, because the intercepting valve would be closed and pressure fluid could not reach the hydraulic cylinder to open that door. When both doors are closed, then either lever can be operated to open one door or the other.

Locking Devices

To prevent both doors being opened simultaneously, there are certain locking devices provided which consist of locking bolts RR, coupled either directly or through the medium of rocking arms and levers SS with the opposite hand levers, such locking bolts being adapted to lock the valve spindles under certain conditions—that is to say, when both doors are closed, the locking bolts are in the "off" position, but when one or other of the controlling levers is operated, the locking bolt connected therewith is shot forward into slot Q or Q cut in the valve spindle of the other controlling valve so as to lock it and prevent it being operated. It will be seen that the locking bolts provide also a device which prevents in any case one door being opened while the other is open, as the slots QQ cut in the spindles are only exactly in front of the said bolts RR when the levers of the controlling valves are in the shut position—that is to say, when the doors are closed. When one door is open the slot of the controlling valve spindle is moved from its original position, the passage being intercepted by the solid part of the spindle, so that the lever of the other door cannot be moved from the closed or shut position, as the locking bolt connected to it has its travel barred by the spindle of the other controlling valve.

Should one or both of the intercepting valves OO not work as intended, this mechanical device provides a further means of preventing both doors being opened at the same time. Moreover, if desired, the use of the intercepting valves could be dispensed with and only the locking bolts used. This one door must always remain shut, and in no case could there be a through passage from one compartment on one side of the bulkhead, or partition, to the other side thereof.

Operation of the System

The working of this system of doors in order to get from one compartment to another is as follows: The door at one side of the chamber or cell is opened first by means of the outside controlling lever to allow the man or men to gain admittance to the cell. This door is then closed by one of the controlling levers inside the cell. When this is properly closed, but not before, the opposite door can be opened by the other controlling lever, enabling the men to obtain admission into the other compartment. In no case can there be a through passage from one compartment to the other, as one door must always remain shut.

In ordinary circumstances each door may be controlled from its respective side, but as it may happen that the panic-stricken men rushing from a compartment where there is danger to the adjoining compartment might easily forget to shut the door of the safe compartment, thus preventing other people from escaping, an emergency arrangement is applied which permits of the controlling of the doors from the opposite compartment; with refer-

ence to the sketch, the lever *S*, besides being connected to the rocking lever that works the locking bolt *R*, is connected also to an arm *Z* pivoted on a shaft which is fitted in a watertight and airtight manner through the side of the chamber; in the outside end this shaft has keyed to it an arm *U*, fitted with a handle and also with an index which works between the positions *open* and *shut*. In this manner the possibility of leaving men locked in a compartment is therefore prevented, as by means of the arm *U* the controlling valve of the opposite door can be worked, and therefore this door can be closed to allow the opening of the other door. If necessary, a device may be applied to give a signal of the completion of the operation of passing from one compartment to the other.

The controlling valves could be of the ordinary type, but the interlocking device might, I think, be applied to some of the patented valves that can be operated from the bridge. In my system there is, however, no need of this control from the bridge, as under no circumstances whatever is there a through passage from one compartment to another; in fact, it may be said, as far as the efficiency of a watertight sliding door permits, that the bulkhead is intact.

As mentioned before, the sketch given is only a diagrammatic one, and the positions of the different parts may be altered to suit circumstances; for instance, in actual practice it will be more convenient to place the controlling valves in the sides of the chamber; in such a case the outside controlling lever would be of the bell crank type, and would be connected to the spindle of the valve; the inside controlling lever would also be of the bell crank type, and it would be connected to a cylindrical bar containing the slot for the locking bolts; this slot would be cut in such a position that it would be just in front of the locking bolts only when the controlling valve was in the shut position. The chamber or cell is provided with means for ventilation, and also with lighting arrangements. This system of doors could also be applied when using electrical or mechanical power, but naturally the gear would be somewhat different in construction, though similar in principle. The invention may also be applied as an air-lock for submarine vessels and for diving purposes, etc.

In connection with the use of doors in the bulkheads of warships, the naval authorities do not allow their application, although they recognize the difficulties under which the engineering force has to work to obtain full efficiency from machinery placed in isolated places, not always run by careful hands, but the naval authorities consider that where there is a *door* in a bulkhead, there is a *hole*. All this may be applied to single doors, as in the moment of danger a plank of wood, a shovel or any other article might be left at the door, which would prevent it from closing, but with my system such a thing is impossible, as there must always be one door closed, and therefore the bulkheads is always watertight. In merchant ships, doors are allowed in bulkheads; with this system of double doors which are *fool-proof*, the safety of such ships would be considerably increased, as, for reasons already stated, the bulkheads would always be watertight, notwithstanding that there would be easy means of communication between the different compartments. I think that this system of doors is *fool-proof* and able to fulfil the demand of always maintaining the watertightness of the compartment, and at the same time permitting safety of entrance to or exit from the compartments.

Tank Steamer Construction*

Recent Growth of Tank Steamer Fleet—Striking Features of Design—Standardization

BY ROBERT W. MORRELL, M. E.

THE growth of the American tank steamer fleet since the beginning of the European War has been so remarkable, and the tank steamers now represent such a large and important part of our merchant marine, that the construction of these vessels cannot fail to be a subject of interest in maritime circles.

At the end of the year 1914 the tank steamers under American registry numbered about 80 (exclusive of barges), of 278,837 gross tons and approximately 416,000 tons deadweight, which at the time represented only about 10 percent of the total steel tonnage of the United States, excluding the Great Lakes and sailing vessels.

At that time shipbuilding in this country was almost at a standstill and the outlook was very gloomy. So complete was the cessation of activity in the shipyards that this period of depression may be said to represent the line of demarcation between the old shipbuilding era and the new.

Early in 1915 shipbuilding took on a new lease of life, and it is interesting to note that it was the construction of tank steamers which started most of the yards on their new road to prosperity. It was the need for oil carriers which rescued the shipbuilding industry and revived it.

Since the beginning of 1915 there have been built in this country 57 tankers (exclusive of barges), of 371,900 gross tons and 519,200 tons deadweight, thus more than doubling the American tank steamer tonnage. It will also be noted that the average tonnage of the individual vessels shows a great increase over that of the vessels previously built.

In addition to the extensive building program carried on, a marked addition to the American tanker fleet was made under the provisions of the Panama Canal Act of August 18, 1914, by means of which 40 foreign-built tankers, aggregating over 190,000 gross tons, or 285,000 tons deadweight, have been transferred to American registry.

We therefore have the honor of displaying the American flag from the largest tank ship afloat—the German-built steamer *Jupiter*, now the *Standard*, of 10,073 gross tons and 17,000 tons deadweight. The second largest tanker is a British vessel of 15,500 tons deadweight, while the United States ranks third, having constructed a type of vessel of 15,000 deadweight. It might be mentioned that six vessels of this size have already been turned out in this country, and that four more are nearing completion.

Up to the present date we have lost six tankships

* Paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1917.

through war causes. Two of these were German-built, three British-built and one American-built. They represent a gross tonnage of 26,537 and 38,590 tons deadweight.

The total number of American tankers now in service is therefore about 170, having a total gross tonnage of 823,200 and a total deadweight carrying capacity of 1,180,000 tons. Thus it will be seen that during the recent period of activity the number of tankships has been increased 112 percent, the gross tonnage increased 185 percent, and the total deadweight tonnage increased 185 percent. Not only is this the case, but it is also found that the tank steamer tonnage is now close to 20 percent of the total steel American tonnage (exclusive of the Lakes), as against 10 percent at the beginning of 1915, thus indicating that the greatest of the recent progress in shipbuilding has been in the construction of tankers, and that the growth of the oil industry has demanded for them a prominent part in our shipbuilding program.

Tank Steamers Building

In addition to this impressive fleet of tankers, we now have under construction in the United States a total of 64 tank vessels, representing 496,680 gross tons and 575,750 tons deadweight, marking the greatest shipbuilding activity in the history of the country. This recent construction on so large a scale could not fail to bring out interesting and instructive features deserving of comment.

The most impressive feature of the modern tanker is the size. Previous to 1915 the average deadweight was 5,200 tons, but the average deadweight of the vessels built in the United States since that time is 9,100 tons.

In 1915 the largest American tankers were the steamers *John D. Archbold* and *John D. Rockefeller,* of 11,500 tons deadweight, but we have since built ten larger vessels, the largest of which attain a deadweight of 15,000 tons. The shipowner's faith in the economy of the large tankers therefore appears to be firmly established. In fact, under certain conditions, the large vessels, trading at ports having limited depth of water and therefore obliged to load part cargoes, have been able to compete with smaller vessels whose light draft permits loading full cargo.

Development of Shelter-Deck Type

Along with the increased size came the development of the shelter-deck type of vessel. The term "shelter-decked type," as commonly used in this country in referring to tankers, applies to a vessel having three continuous steel decks, the uppermost of which is the strength deck. According to Lloyd's Register, a shelter-decked vessel is one in which the uppermost or shelter deck is a light, continuous superstructure, with one or more tonnage openings. If without tonnage openings, it is an awning-decked vessel, while if the upper scantlings are heavier it becomes a spar-decked vessel. The commonly accepted use of the term "shelter-decked vessel" in this country, however, is in reference to any vessel having a continuous weather deck, as opposed to the type having raised forecastle, bridge and poop.

The first shelter-decked tankers built in this country were the sister ships *John D. Archbold* and *John D. Rockefeller,* of 11,500 tons deadweight each. These vessels had the oil tanks carried up to the upper deck, which is the next deck below the shelter deck. The oil hatches were located on the upper deck, and gas trunks were built around the hatches and extending from upper to shelter deck, to keep the gases from permeating the 'tween-deck space.

Experience has proven these trunks a source of danger to the ships, as the heavy gases accumulate at the hatches and great caution is necessary to prevent men from being overcome when entering the tanks. Apparatus for clearing these spaces of gas has since been installed.

The next step in the development of the shelter-decked type was the carrying of the expansion trunks right up to the shelter deck. This was embodied in the *Charles Pratt* and subsequent vessels of that type with great success.

With this arrangement, the expansion trunk bulkheads extend from the second deck (or main deck or tank deck, as it is variously called) up to the shelter deck, thus making the expansion trunk two decks in height. The summer tanks are arranged outboard of the expansion trunk between the second and upper decks. The oil hatches for both main and summer tanks are located on the shelter deck, and small trunks, extending between the upper and shelter decks, are built for the summer tanks. Outboard of the expansion trunk, between the upper and shelter decks, are open 'tween-deck spaces above the summer tanks.

The principal advantages of this design over that in which the oil is not carried above the upper deck are as follows:

1. An increase of about 10 to 15 percent in the cubic capacity of the tanks is obtained, which is of great benefit when carrying light grades of oil.

2. The vessel can be trimmed when loaded with much better results, as the expansion trunk extending through two deck heights gives great scope for the desired ullages. If the vessel has a tendency to trim by the head when leaving port on account of full fuel tanks forward, this can be overcome with the present design by leaving large ullages in the forward cargo tanks and smaller ullages in the after tanks. It is also possible, as fuel is used, to maintain any desired trim by transferring the cargo. The deep trunks allow great leeway in this respect.

3. On account of the oil hatches being on the shelter deck, the danger of getting gas in the 'tween-deck space is avoided.

4. The center of gravity of the cargo is higher, making an easier ship.

5. The expansion trunk and center line bulkheads, extended up to the shelter deck, provide valuable additions to the longitudinal strength of the ship.

To offset the above, it should be noted that additional steel is required to carry the trunks to the shelter deck and that the scantlings must be increased on account of the increased head of oil. Therefore a slight increase in the hull weight is involved, and, if the vessel is to carry only heavy crude or fuel oils, the extension of the oil space above the upper deck is not advisable. This brings out the fact, which is constantly cropping up, that to design the most economical tankers they must be specialized for particular trades and used in no other trades. The point just mentioned illustrates this—if the vessel is intended to carry light oils, the oil space should be made as large as possible by extending it up to the shelter deck; but if intended to carry only heavy oil, large cubic space is not required and the oil space may terminate at the upper deck.

It should be noted in passing that with the oil hatches on the shelter deck it is not advisable to locate the living quarters amidships directly on the oil-tight deck. To overcome this, on all vessels of this type the accommodations have been raised 3 feet 6 inches off the shelter deck, leaving an open space under the house. The house plating is extended down to the deck on the front and sides, but is open for access at the after end. The house with this construction requires particularly secure fastening to the shelter deck.

It is impossible to avoid bringing up some of the valve operating rods into this space under the house, but these are extended out clear by means of bevel gears.

There have recently been built, or are now building, several shelter-deck vessels in which the oil hatches are located on the upper deck, and the 'tween-deck space is entirely open, without gas trunks, but the majority of the shelter-decked ships are now of the type just described, namely, with the trunk to the shelter deck. This type is highly satisfactory for an all-around tanker.

A recent special design which is worthy of note is embodied in the tanker *D. G. Scofield,* in which the entire 'tween-deck space, between upper and shelter decks, is made suitable for carrying case or barrel oil, in addition to the bulk cargo in the tanks. The oil hatches are on the upper deck and large cargo hatches are provided in the shelter deck each side of the center strake, which is continuous. Three masts are fitted with complete cargo-handling gear consisting of booms and winches. This is another instance, however, of adaptation of a tanker to special trade. Such package cargo-handling equipment on the majority of tankers would be useless.

In considering the subject of shelter-decked tankers, the question naturally arises as to what determines whether a vessel shall be built with a shelter deck or a forecastle, bridge and poop deck. The answer is somewhat obscure, but the determining factors seem to be mainly matters of size and of personal preference. The dividing line seems to be in the neighborhood of 10,000 or 11,000 tons deadweight, the vessels above that size being almost without exception shelter-decked vessels.

The main point involved is one of draft. Increasing the size of the vessels it is not desirable to increase the draft in proportion. The shelter-decked type lends itself to carrying an increased deadweight on a limited draft without adopting extreme proportions. The shelter-decked type is also preferable for strength purposes in the larger sizes.

With regard to tonnage openings, a few shelter-decked vessels of this nature have been built, and they have the advantage of small tonnage measurement combined with good structural design due to small length to depth ratio; but the greater depth required tends toward a heavier ship.

For purposes of comparison I have made a rough approximation of the general characteristics of four steamers, each of 11,000 tons deadweight capacity but of different types, as follows:

1. Shelter-decked vessel with expansion trunk carried to shelter deck.
2. Shelter-decked vessel with oil space up to upper deck only; no tonnage openings.
3. Same as (2) but with tonnage openings.
4. Forecastle, bridge and poop type.

In working out the dimensions the length and beam were kept constant and the depth and draft allowed to vary to suit the different conditions.

The following table gives the results of the calculations, which have not been carried out to any degree of refinement but which are sufficient to indicate what may be expected of the different types:

Comparison of Four Types of Tankers of 11,000 Tons Deadweight Each

Type	L.	B.	Draft	Depth to Upper Deck	Depth to Shelter Deck	Displacement	Weight of Ship Light	Cargo Capacity, Cubic Feet	Gross Tonnage
1....	450′	59′	26′ 4″	28′ 0″	35′ 6″	16,270	5,270	483,000	7,900
2....	450′	59′	25′ 6″	27′ 10″	35′ 4″	15,700	4,700	420,000	7,850
3....	450′	59′	26′ 0″	31′ 0″	38′ 6″	15,800	4,800	458,000	7,750
4....	450′	59′	26′ 6″	34′ 0″	....	16,000	5,000	460,000	7,850

From the table it will be noted that type (1), although a heavy ship, has great cubic capacity, and is therefore best adapted to carrying light grades of oil. Type (2) is a lighter ship, for reasons previously explained, but has small cubic space and is therefore suitable only for heavy oil trade. Type (3), on account of the tonnage openings, requires great depth, resulting in increased weight of hull and increased cubic capacity. Type (4), it will be noted, requires greater draft and is rather heavy but has plenty of room inside.

It must be remembered that all of these vessels will carry a deadweight of 11,000 tons, and therefore the variations and possibilities with the deadweight fixed, and even with length and breadth fixed, are apparent. The results go to show that the vessel, when designed, must be made to conform to the conditions under which it is intended to operate.

In the matter of cubic cargo space, for instance, let us assume that for a vessel of this size the fuel carried will be 1,050 tons, with 250 tons fresh water, stores, etc. This leaves 9,700 tons for cargo, which, if heavy fuel oil, occupies 358,900 cubic feet; if refined oil, 436,500 cubic feet; and, if naphtha, 485,000 cubic feet. A study of these figures will readily give an indication of the respective capabilities of the vessels.

The foregoing types were assumed to have the usual sheer line, the middle portion of which, if faired on the ¾-inch lines, would show an easy curve. It must be noted, however, that there is a growing tendency at present to adopt a straight sheer line amidships, and, in fact, there are tankers now under construction embodying this idea.

Effect of Straight Sheer

In order to investigate the effect of the straight sheer, the sheer line in type (1) was changed and made straight for 55 percent of the length amidships, fairing into the original height at the ends. This change made an increase in the molded depth to shelter deck of 2¾ percent. The principal objection to the straight sheer is the reduction in height of shelter deck for a space beginning at the stem and extending to a point about 35 percent of the length abaft the stem, where the old line crosses the new. The greatest reduction in height occurs between 15 and 20 percent of the length abaft the stem. The reduction amounts to only a few inches and is not a serious difficulty.

With the new sheer line, the allowable draft will not be noticeably changed, and the difference in hull weight will be negligible. The advantage structurally of the straight sheer is obvious, as it will permit practically universal work throughout almost the entire length of the oil space, and the frames, bulkheads, etc., will be alike for every tank except the end ones.

Subdivision of Cargo Tanks

A prominent feature of recent construction has been the subdivision of the cargo tanks into groups for the carrying of different grades of oil. If two different grades are separated by a single bulkhead there is danger that a leak in the bulkhead, permitting a mixing of the grades, will spoil the cargo. The first step was to place the pump room amidships, which, aside from being a most convenient location for pumping, divides the tanks ino two groups in which different grades of oil can be loaded without danger of mixing.

This was carried further and cofferdams inserted between the tanks. The 15,000 ton deadweight tankers previously mentioned have ten main cargo tanks divided into three groups with a separate pumping system for each. Several smaller tankers have similar divisions.

This is another example of the incorporation of special requirements for special trade. As an extreme case, there is one vessel now building on the Atlantic coast which has five cofferdams and a pump-room dividing the cargo tanks into four separate blocks. One of the cofferdams, however, is located between the after fuel tank and the fire-room. Many of the modern tankers have this arrangement, which is a wise safety precaution originated on account of fires started by oil in the fire-room due to leaky bunker bulkheads.

Where such cofferdams are built, they are provided with tunnels for use in the event of the vessels burning coal. The tunnels are blanked by oil-tight bolted doors on each end, but if used for coal the oil-tight doors will be removed and vertical sliding bunker doors fitted. The fuel-oil piping passing through the cofferdam is fitted with a valve on each bulkhead, the valve on the bunker side being controlled from the deck. The cofferdam is also provided with a sea valve controlled from the deck, for flooding in case of fire. Thus, if a fire originates in the boiler room, it can be isolated from the fuel supply, while if the fire starts in the tanks the propelling machinery can be kept intact.

Cylindrical Tanks

An important feature of the tank steamer situation is the construction of steamers with cylindrical tanks. Six of this type of vessel have been built or are being built by the Chester Shipbuilding Company. Aside from the saving in hull weight in this type, it has the advantage that the cylindrical tanks can be constructed by people other than shipbuilders. Under the present conditions this fact bears considerable weight. The present design shows a series of tanks the diameter of which is as great as the vessel's framing will permit. A recent design which places smaller tanks on opposite sides of the center line appears to have an advantage with regard to preventing listing of the vessel.

If it is desired to carry cargo or ballast outside the cylinders—that is, between the cylinders and the ship's sides—it is important that the head of water or oil outside the cylinders be not greater than that inside, and for this purpose automatic non-return valves are provided.

The cylindrical tanks are particularly well adapted to conversion jobs, and the few recent conversions of general cargo vessels to tankers have been on this basis. It is a remarkable fact, in view of the great demand for tank tonnage, that so few vessels have been converted to bulk-oil carriers, and rather reflects the skeptical attitude of the shipping community toward converted vessels.

Adoption of Rolled Tee-Bar Section

Returning to the ordinary tanker and coming down to structural features, it appears that the greatest single item which made for better construction has been the adoption of rolled tee-bar section for oil-tight work. Until recently, tee-bar was not generally rolled for ship use and was unobtainable in proper sizes. Under pressure from shipbuilders and shipowners, however, the mills have adopted this section in several sizes and the advantages of its use in the construction of tankers are generally recognized.

Tee-bar is now being used for the bracket connections of longitudinals to bulkheads, and is replacing single and double-angle connections for this purpose. It has the advantage of being made oil-tight much more readily than the angle connections, for the double-angle clips have a habit of leaking at their ends, and the single-angle clip gives difficulty along its heel.

The usual size of tee-bar for bracket connections is 6½ inches by 6½ inches by .45 inch, double riveted in both flanges. Where this replaces a single-angle clip 3½ inches by 3½ inches, single riveted, it is apparent that an equal number of rivets can be obtained in a much shorter tee-bar clip. It is inadvisable, however, even with equivalent rivet connections, to reduce the depth of the brackets on account of using shorter tee-bar clips, and the tendency is, therefore, to use longer tee-bar clips than the riveting requires in order to maintain the effective portion of the brackets.

A further use of tee-bars is for bounding connections on oil-tight work. On some of the shelter-decked tankers just built, in which the expansion trunk is carried to the shelter deck, the bar is used to connect the upper-deck plating to the expansion trunk bulkheads, with excellent results. If a single angle were used instead, the heel would require to be calked for the entire length.

Tee-bar is also being used to connect the top of the fore deep tank (under the forward hold) to the fore-peak bulkhead and to the forward cofferdam bulkhead. The shell connection, where the heel need not be calked, is angle bar, and this butted against the tee-bar and straps fitted. The Sun Shipbuilding Company is using tee-bar for the boundaries of the transverse oil-tight bulkheads, and, while the writer has approved this as an emergency measure, there is some question whether double bounding angles are not necessary to maintain proper oil-tightness.

The use of the tee-bar for bilge-keel attachments has long been established as the only thoroughly satisfactory connection, and recent experience has indicated that these tee-bars should be at least 9/16-inch thick.

Use of the Multiple Punch

One other feature is of great importance for oil-tight work, namely, the multiple punch. This has not been used extensively up to the present, but its possibilities are so great that it is believed this machine will soon be in common use in building tankers. The first requirement for oil-tight work is that the rivet holes shall be fair—a result which, unfortunately, is not always obtained with the common single punch, especially when operated by a gang on piece-work. By using the multiple punch, the holes are spaced mathematically correct; every space is exactly the same as every other one, therefore the holes cannot fail to match when the work is erected. If, therefore, the multiple punch will insure fairness of holes, its importance for oil work is obvious. In addition to this advantage, the actual cost of punching, reaming, riveting and testing will undoubtedly be lowered, while the actual laying-off of the work for punching is entirely eliminated where this punch is used.

It must be understood that this type of machine imposes severe restrictions on the rivet-spacing, and it is only by painstaking care in the original design and in developing the riveting details that the multiple punch can be used. The chief difficulty is that the spacing in frames or longitudinals must be exactly twice that in seams and butts, which may involve some additional rivets not required by the rules. The spacing in way of bulkheads and transverse frames presents a knotty problem, and it may be that some holes will have to be single punched or drilled.

The multiple punch is, of course, only suitable for work on the dead flat, but if properly worked out it can be used on a very large portion of such work and will result in making the parts universal to a far greater extent than at present.

In view of the large number of tankers recently sunk by submarines, many of which have been in ballast, con-

siderable thought has been given to the question of ballasting in order to give the most favorable conditions if torpedoed. The ballast condition of a tanker is a variable quantity, as it may be altered at will to suit weather conditions or for other reasons. Many claim that if all tanks are filled with water to bring the ship to her load draft, and several tanks are then pierced by explosion, the condition of trim and list will be changed but little, whereas if some of the tanks are empty and then pierced the vessel will settle, due to filling the tanks previously empty, and will list as well, due to the additional water on one side only. On the other hand, if water is carried in all the tanks, obviously some of them must be slack tanks and be even more likely to cause listing.

Protection Against Torpedoes

After carefully considering the subject, the writer's conclusions are: First, that no slack tanks should be carried, thereby eliminating this danger from listing. Second, that the vessel be given as much reserve buoyancy as possible, which may be the means of saving the ship if torpedoed in the machinery space; therefore as little ballast should be carried as weather conditions will permit, but whatever is carried should be in full tanks so distributed as to equalize the loading to best advantage. Third, that gate-valves be fitted in the center-line bulkhead near the bottom of each tank, operated from the deck, but left open at sea; thus, if empty tanks are pierced, the water will equalize and prevent listing.

Experience indicates that a torpedo explosion shatters the structure in the vicinity and renders it non-watertight or non-oiltight for a considerable radius. If several tanks are full, the water or oil in them, being practically noncompressible, transmits the shock and destroys the watertightness for a much greater radius. This is another reason for having empty tanks. If the shock of explosion is so transmitted by water in the tanks as to cause the fuel-oil bulkhead to leak into the fire-room, the ship is doomed; therefore anything making this a possibility must be avoided.

Standardization

With reference to the subject of standardizing, this is a matter which has been in the air for some time, and the standardization of tankers has been discussed on many occasions.

So far as the standardization of fittings is concerned, there are great possibilities in this direction. It is understood that the Bethlehem Steel Corporation has already taken steps to standardize fittings in its various plants, and it is to be hoped that this will include fittings for tankers, such as oiltight hatches, shell manholes, tank ladders, cargo pipe fittings, valve operating gear, heater coils, gas vents, etc. It would be of great advantage if standard fittings of this nature could be adopted by all the shipyards in the country.

As to standardizing tankers themselves, it would be interesting to note that the 64 tank vessels now under construction in American yards represent nineteen distinct types or designs and are being built in sixteen different shipyards for sixteen different owners, considering vessels building for "foreign account" as being under one owner. At least there were sixteen different owners prior to August 3, at which time all these vessels were requisitioned by the United States Shipping Board, Emergency Fleet Corporation. The construction of these vessels is now in the hands of the Corporation, represented by the district officers; at the urgent request of tank-ship owners, the district officers have retained the services of the former owners' inspectors, in order that inspection by men thoroughly trained in oiltight work might be assured.

The nineteen types above mentioned range in size from 5,000 tons to 15,000 tons deadweight and represent almost every possible variation in design. They were designed by competent men to meet specific requirements. Practically every oil company and every shipyard has its own standard type of tanker, or in many cases three or four standard types, all varying in accordance with the different needs of the business and with the different ideas as to how these needs are best met.

It has already been pointed out that special vessels are required for special trades in order to obtain the best results. A vessel designed to carry heavy oil is not suitable for transporting refined oil, and vice versa. A vessel designed for straight cargo is not suitable for a mixed cargo, but a vessel designed for mixed cargo is needlessly complicated and expensive for shipping straight cargo. Owners trading on the west coast only, naturally desire to take advantage of the deep water to adopt wholesome proportions of length to depth, whereas other owners, trading in ports where draft is restricted, must adopt different proportions. Some trades require vessels with fuel capacity for ten days, others for forty days. In many cases large vessels are the most economical, but large vessels cannot be built in all yards and cannot enter all ports.

It is obviously impossible to find a single vessel to meet all requirements, and if an attempt at a compromise is made it will place practically every oil company at a disadvantage in having to operate vessels which are not quite suitable.

The nearest approach to efficient standardization would be in the adoption of at least four standard designs, consisting of two vessels, a large one and a small one, for the sole purpose of carrying cargoes of heavy oil and two vessels, a large one and a small one, especially for carrying mixed cargoes of light oil.

In carrying heavy oil, such as fuel oil or crude oil, it is possible to load different kinds in the same vessel without danger of mixing, due to leakage or due to pumping one kind through the same pipe line as another. Therefore there is no need of subdividing the tanks for different grades.

The smaller vessel for this purpose would naturally be of the forecastle, bridge and poop type, and the larger one of the shelter-decked type. In both cases small fuel tanks for bunker use are sufficient, as it is possible for a long voyage to carry half a main cargo tank of fuel, or to carry it in summer tanks. The permanent fuel-oil tanks should consist of a short tank at the forward end of the cargo tanks, and another at the after end, thus enabling the vessel to be trimmed as the fuel is used. With this arrangement no cofferdams whatever are required in the vessel. The pump-room in this type of vessel should be located between the after-fuel tank and the boiler-room, thus separating the oil from the fires, and should contain the fuel-oil pumps and heaters as well as two cargo-oil pumps. A simple system of cargo-oil piping whereby both pumps can draw from the tanks and discharge overboard independently is sufficient. The summer tanks may be fitted with drop-valves, connecting them with the main tanks, or they may be piped for fuel oil, as conditions require. All tanks in these vessels should be fitted with heater coils.

For the standard vessels intended to carry mixed cargoes of light gravity oils, the smaller would be of the forecastle, bridge and poop type and the larger of the shelter-decked type with expansion trunks carried up to the shelter deck. In both vessels rather larger fuel-tank capacity

is required. On account of the danger in carrying naphtha next to fuel oil, cofferdams should be provided at each end of the cargo tanks. The cargo pump-room should be located amidships, thus dividing the cargo tanks into two groups. For safety, a cofferdam between the after fuel tank and the fire-room should be provided and the oil-burning apparatus installed in a separate enclosure in the fire-room wing. A fuel pump is required forward to transfer fuel aft from the forward tank. The cargo oil piping system should permit of the pumping of different grades of oil from the forward and after groups of cargo tanks simultaneously and independently, without the two grades using any piping in common. The cargo piping must not extend into the fuel tanks. The summer tanks should be piped separately. Special precautions against gas must be provided, and the gas vents from the tanks fitted with automatic relief valves. Special ventilation for the pump-room and cofferdams must be furnished.

The foregoing outlines briefly the minimum that could be expected in the standardization of tankers. Assuming, however, that such standard designs were prepared and approved, it is not clear just what would be gained by throwing out all the present designs and adopting new standard designs. The vessels now building were designed especially for certain definite purposes, best known to their original owners, and it is not likely that standard designs would serve such purposes any better. The ships now building are duplicates of other ships previously built in the same yards, and the experience gained on the previous vessels is an asset not lightly to be ignored. The advantage of having all plans, material orders, templates and patterns for existing vessels places a handicap on standard ships which will take time to overcome, and the result would be to slow up construction instead of speeding up.

Unquestionably, the quickest and most economical means of building additional tankers is to duplicate existing vessels, for which the designs are already perfected and which conform specifically to the needs of the oil business. In this way only can the cheapest and quickest construction and the greatest economy of operation be attained.

Future Prospects of Tankship Construction

The future tankship construction is, however, an uncertainty. All of the vessels now under construction are for 1917 or 1918 delivery. When these vessels are completed, the building of tankships will, according to present indications, be at a standstill in this country. So far as we are aware, the United States Shipping Board has not, up to the present time, made any provision for tankers in its shipbuilding program. The board is promoting the construction of a huge fleet of cargo carriers to transport supplies to our allies and to handle the nation's increasing commerce; but it has entirely ignored one of the most important of the Allies' necessities and one of our own principal industries in excluding tankers from its programme.

The nation's oil business has advanced with enormous strides and is still advancing. The demand for tank-steamer tonnage is greater than ever, and new vessels will be needed constantly to meet the ever-growing transportation requirements. We have lost many tank ships through war causes and will undoubtedly continue to lose them. In spite of all this, there is no provision for future requirements. Oil companies and shipbuilders have endeavored to obtain the board's permission to proceed with tankship construction, but up to date this permission has not been granted.

The present situation is, therefore, that the Shipping Board is placing no new orders for building tankships and will not permit anyone else to do so. This policy can have but one result, and, if immediate steps are not taken, we shall unquestionably be faced by grave shortage of tank-steamer tonnage. This condition is most serious and urgent and demands the earnest consideration of all shipping men having the nation's welfare, and the cause in the great struggle which it represents, at heart.

BOOK REVIEWS

The Aldrich Marine Directory. Compiled by H. L. Aldrich. Size, 4½ by 8 inches. Pages, 202. New York, 1918: Aldrich Publishing Company. Price, $5.

With the rapidly increasing size and importance of marine industries in the United States, a complete directory of American shipbuilders and ship owners is indispensable. To meet such a need, the Aldrich Marine Directory has been carefully compiled, giving lists of concerns in the United States which build and repair vessels, and also lists of steamship, steamboat and other vessel owners using the American flag. No attempt is made to classify the vessels owned by the government, although the various departments of the United States Government have under their control considerably more than 1,000 steam vessels.

The list of shipbuilding and repair yards is arranged according to the location of the yards geographically, and is divided into four distinct groups—those on the Atlantic coast, the Mississippi Valley, the Great Lakes and the Pacific coast. In each case the names of the officials of the yard, its capacity, number of launching ways and the nature of the work are given. The list of vessel owners is arranged in a similar manner and gives not only the names of the officials of the steamship and steamboat companies, but also the names, gross tonnage and service of the vessels owned by the companies.

The book is of pocket size, and as the data which it contains are tabulated, the work forms a most convenient ready reference book.

Heat. By John Roger. Size, 4½ by 6¾ inches. Pages, 77. New York, 1917.

Physicists, who are not satisfied with the ordinary treatment of the subject of thermodynamics, will find the subject attacked in this pamphlet from an entirely new viewpoint.

The author starts out by defining heat as a diamagnetic or negative force, acting in opposition to the positive force of atomic attraction, and temperature as the negative atomic stress produced between the atoms. He shows that the working value of the unit of heat is not 778 foot-pounds, but is proportionate to the temperature.

There is no such thing as latent heat, he says, only developed and undeveloped energy. It is shown that the properties of different forms of matter cannot be compared by quaitities of equal weight, but that the specific heat of different materials should be dealt with by equal volumes. According to the author, the specific heat of matter has no apparent relation to the atomic weights.

Such features of the pamphlet as have been indicated above should at least be sufficiently striking to arouse the interest of those who have been baffled by the inconsistencies of thermodynamics as usually presented.

Rear Admiral Francis E. Bowles has been made assistant manager of the Emergency Fleet Corporation, with headquarters in Philadelphia in order to speed up work at the new government yards.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs.

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Repairs Made on a Cracked Pump Cylinder

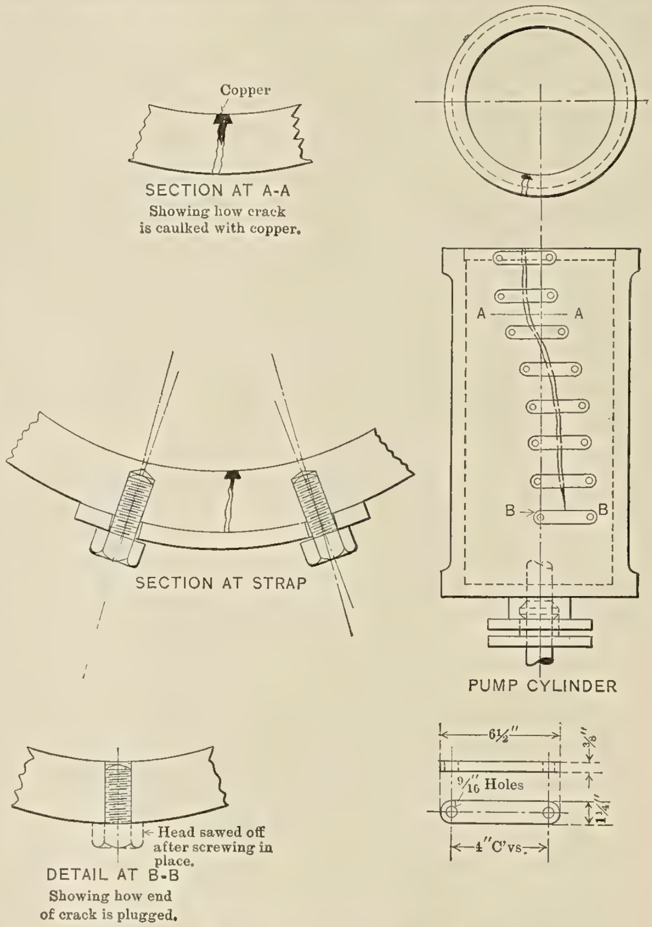
My feed pump cracked while at sea when our vessel was not far from a small southern port. Although it was possible to run the ship without the pump, the owners thought it best to stay in port until the ship's full pumping capacity could be used. As the steam cylinder was cracked for three-quarters of the length, and, on account of the general shape of the cylinder, bands could not be used, the port representative of the owner had about made up his mind that it was necessary to send for a new cylinder. The writer happened to remember, however, of a similar case which had been repaired in the following manner, and was given forty-eight hours to try it out in.

We had some flat iron lying around, and I had it finished into strips, as shown in the sketch. To keep the crack from lengthening, a hole was drilled and tapped out and a ½-inch bolt put in and the head knocked off flush after screwing up solid. This is shown in section *B-B*. Then 2 inches to the left of the crack, starting at the lowest part of the crack, ½-inch holes were drilled and tapped out, being careful not to drill clear through the cylinder. As this was a vertical pump, the holes were spaced 3 inches apart vertically. These holes, instead of being drilled in a line—that is, run true to the center of the cylinder—were toed in slightly. The reason for this will be shown later. A stud was carefully fitted to each hole and the stud and hole marked with corresponding numbers. The strips were then heated to a low temperature so they would bend easily, and bent to the outside radius of the cylinder.

As the cylinder was sprung considerably towards the top of the crack, a strong clamp was fitted about this time and the crack was pulled together. The strips were fastened by the studs in their left ends and each strip marked for this definite position. Any final touches to fit the strip closely to the cylinder were then made. The holes drilled in the right end of the strip were very carefully scribed on the cylinder and the strips removed.

Now comes the part of the job upon which success depends. The cylinder must be pulled together and firmly held by the power of contraction of the strips in cooling off after being heated up. As the elastic limit of the strips is reached when the stretch is 1/50 inch and the pull exerted at that length is about 8,000 pounds, which was sufficient for our needs, there was no need of giving the strip more stretch than that, notwithstanding the fact that that amount of elongaion can be obtained with a comparatively small temperature rise (some 400-odd degrees). This, however, is a good thing, in that it gives us a margin of action in slow work between the forge and bolting up in which there is sure to be obstacles which, even if small, take up time while the strip is cooling.

The center of the lowest hole, therefore, was marked 1/50 inch to the right of the position scribed on the cylinder when the strap was in place. If the crack were closed tightly together at all points this would be the proper allowance for each strip, but, as this is never the case, the engineer must use his judgment as to the proper allowance for each strap. The distance depends upon the amount the crack is sprung, upon whatever, if anything, is holding it apart, and also upon the length of the strip,



Details of Repairs to Cracked Pump Cylinder

allowing an elongation of 1/200 inch in every inch length of strip between stud hole centers. Possibly this amount can be allowed in extreme cases where the crack must be pulled together through considerable distance, but, if the crack can be partially closed in that way, this is not advised. On my job, as the crack was pulled pretty well together, I increased the spacing from 1/50 inch at the bottom to 1/25 inch at the top. It must be remembered that the holes in the strips are 1/16 inch larger than the studs, and allowance must be made for this by pulling the strip to its extreme right-hand position and then measuring for the center from the right-hand mark of the scriber. These holes are drilled and tapped, being toed in and also drilled part way through, as in the other side of the crack.

The studs are fitted and marked, as on the other side, and then the straps are placed in a forge handy to the cylinder. While a couple of men heat them up, two others work at the cylinder setting them on. Speed is necessary here as well as system, for the strips should be put on while at the maximum temperature (a good red heat is

sufficient here), and the strips should follow each other as close as possible. The strips are put on, starting at the bottom and working toward the top. The studs are toed in, so that the strip will tend to hug the cylinder, thus binding the whole together.

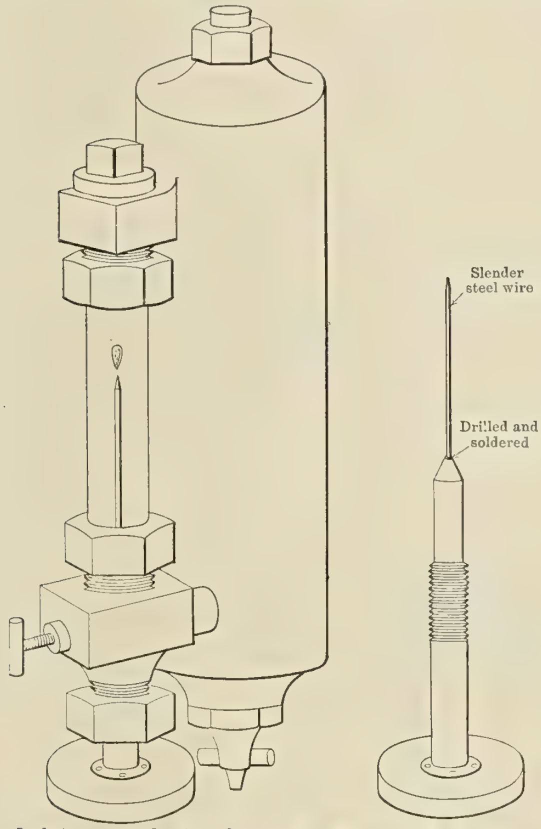
To make the job steam-tight, I made some dovetailing tools out of files and other scrap aboard, and cut a dovetail along the crack, as shown in section *B-B*. I then hammered out some strip copper into a wedge and hammered it into the crack, calked it in and finished it over with the ball peen, finally scraping it smooth. The hardest part to get tight is the bottom of the crack, where the stud was put in. By using a little care, however, this is not very difficult.

The pump was set up and working thirty-six hours after the inspection by the owner's representative, and as long as I was on the vessel it worked perfectly, and so far as I know is still standing up to the work. As the time necessary for getting a new pump cylinder to this port would have been nearly two weeks and the cost a considerable amount, I figured that the emergency repair was worth the try.

J. P. Knoblauch,
First Assistant Engineer, S. S. *W. C. Teagle*.

Keeping the Sight Glass Clean

Most engineers know what a lot of trouble it is to keep the inside of a sight feed glass of any lubricator clean, and if they are not kept clean one cannot tell how they are



Lubricator with Attachment for Keeping Sight Glass Clean

feeding half the time. One of the watch engineers devised a scheme, which is illustrated in the sketch, of having the drop of oil impinge and travel on a slender wire two-thirds of the length of the glass. This keeps it clear of the side of the glass. The wire is secured to the valve spindle, as shown at *A*.

The scheme works well, and saves much bother and many glasses, for in the frequent cleaning of the dirty glasses many would get cracked and broken by the handling. We had experimented with the kink of putting a bit of common yellow soap into the lubricator when filling. This kink is an old one, but we never could get satisfaction from it, though it did help for a short time after soap was placed in.

Concord, N. H. C. H. Willey.

Use of the Telephone for Finding "Shorts" in Electric Wiring

Having found the feeder, or wire in which the "short" has occurred, it is still often the hardest part of the work to locate its exact position. Sometimes it will show itself by heating up the wire in the neighborhood, but very often there is no indication whatever, especially such as can be seen by the practiced eye, where some of the cables are fixed on board ship. The first thing to be done, however, should be to go carefully through the whole of

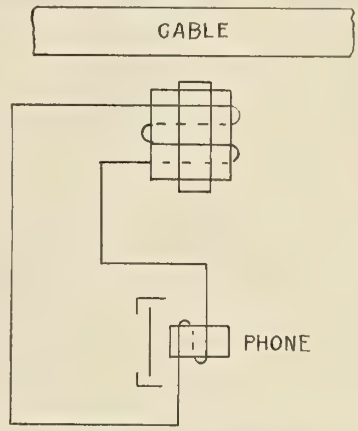


Fig. 1.—Diagram Showing the Arrangement of a Telephone and a coil of wire with which to exlore the cable for a "short."

the cable or wire in which the "short" is; if it is possible the cable or wire should be passed through the hands, but care must be taken to avoid shocks in doing this. If many "shorts" occur in the cables of the ship, considerable skill will soon be acquired in noting what would be very minute indications. If there is no indication that is of any service, the telephone can be brought into use, and will indicate the position of the "short" to a dead certainty.

For the purpose, one of the telephones that are used by operators in telephone exchanges or wireless stations may be used, though it should be wound differently from those. The headgear telephone, in which one or two receivers are held to the ears by a strap across the head, is recommended because it leaves the hands quite free.

The idea underlying the telephone test is: A very moderate current is sent through the cable in which the "short" occurs, the current that can be obtained from one or two dry cells, for instance, and that will produce no appreciable heating effect; if it is interrupted periodically by any convenient method, any form of make and break, and a telephone is brought near the cable in which the interrupted current is passing, a click will be heard in the telephone every time the circuit is made and every time it is broken. If the telephone receiver is a fairly sensitive one, or if the current that is made and broken is fairly powerful, the click will be heard in the phone strapped on the head, without any accessories.

As the testing may have to be carried out in awkward and noisy places, the action of the make and break can be multiplied by forming a secondary circuit, in which

the telephone and a small coil of wire contained on a reel will be included, as shown in Fig. 1. The best results will usually be obtained if the winding of the small coil be of about the same resistance as that of the telephone, though it may be of fairly large diameter.

Improved results will be also sometimes obtained if a dry cell is included in the circuit, as shown in Fig. 2; a very small cell that can be carried in the pocket, or can be attached to the coil, will answer the purpose.

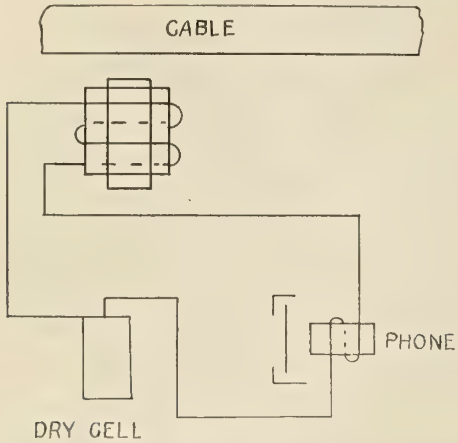


Fig. 2.—Diagram Showing a Similar Arrangement; an exploring coil, a telephone, but with a dry cell included in the circuit.

The make and break may be done by hand; say by an assistant touching the end of a wire on its terminal, say the wire that is connected to the terminal screw of the dry battery; or if it is inconvenient to have an assistant, a simple form of make and break could easily be devised, such as that shown in Fig. 3, driven by an electric motor or a belt from any convenient source of power. The make and break, as will be seen, consists of a cylinder of insulating material, a piece of dry wood would answer very well, on the surface of which one or more strips of brass is mounted. A brass spring is made to bear on the surface of the cylinder and the connections are as shown in Fig. 4. The brass spring and the brass strip on the wood cylinder form the stationary and moving parts of the switch; when the brass strip is under the spring, the switch is closed and a click will be heard in the telephone, and when the brass strip leaves the spring the circuit will be opened and another click will be heard in the telephone.

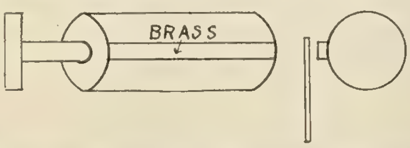


Fig. 3.—Diagram Showing a Revolving Make-and-Break Apparatus

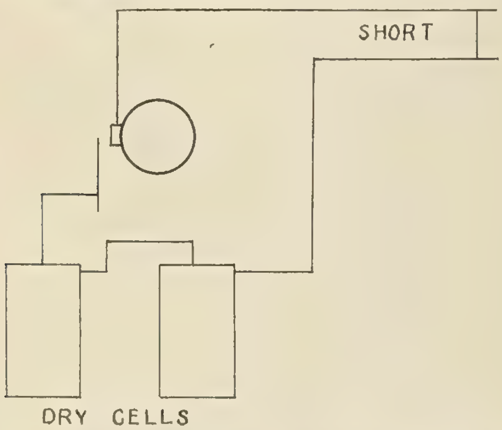


Fig. 4.—Diagram Showing the Arrangement of the Connections for Testing for a "Short," with a Couple of Dry Cells Connected to the Two Cable Conductors, the Current Passing Through the Make-and-Break. The Cables Are Shown by the Lines Joined at the Short, and the Make-and-Break Is Shown Above the Dry Cells on the Left.

The operation of the apparatus is as follows: The telephone having been strapped on the head and connected to the reel of wire, and the circuit of the contact breaker and battery having been formed with the cable to be tested, the operator works outwards from the switchboard where the last lamp indications were obtained, holding the exploring coil, the reel of wire, close to the cable to be tested. As long as he is on the near side of the fault he will hear the click of the telephone at every make and break, and when he has passed the fault the clicks will cease.

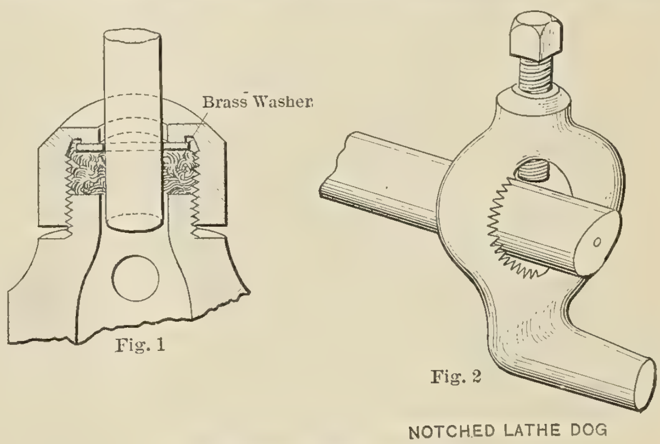
The procedure is exactly the same where there are two faults on two cables, the positive and negative; but each cable must be tested separately and the connections of the make and break circuit must include earth.

In some cases where the fault is not a complete short circuit, where the resistance of the fault is high, not sufficient to cut off the current entirely from everywhere else, the indication by the telephone will not be so clear as where there is a dead short; but a little practice will enable sufficiently clear indications to be obtained to enable the position of the fault to be located. The clicks in the telephone will have a certain vigor up to the position of the fault, and will then begin to be less and less, so that by working forwards and then backwards the position of the fault will be sufficiently clearly indicated.

Bath. Sidney F. Walker.

Kinks from the Note Book

It has been a profitable hobby and a mighty useful one to the writer to gather into a note book the ideas and kinks applicable to his calling. When visiting aboard another ship or when on shore and nosing around the stationary plant and machine shops, I have found many kinks and data to add to my own original thoughts in the notebook. From time to time I have contributed to the trade papers many of these ideas, and thereby have passed along to others anything found worth while. The kinks shown in the sketches are a few taken from this note-book and are in most part original. While they are quite simple, they are nevertheless useful.



Handy Kinks to Be Remembered

When tightening upon a gage glass packed with rubber grummits we often find that the packing has adhered to the inside of the packing nut and will not readily turn. Often it results in a broken glass. The sketch shows a stunt that serves very well to cure this disagreeable trouble. A metal washer is placed inside the packing nut as shown in Fig. 1. The washer must be an easy fit to both the nut and glass. With this washer in place, the grummit is prevented from sticking to the nut, and it is easily taken up when leaking.

Fig. 2 shows how to make a sure-grip lathe dog. The ordinary dog will often slip on round stock when a heavy

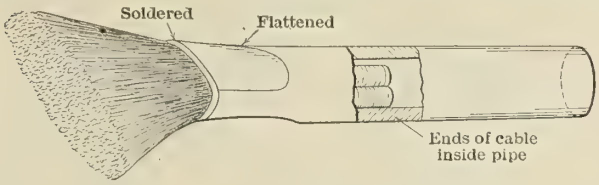


Fig. 3.—Wire-Cleaning Brush

cut is being taken. If serrated with a file on the inside, as shown, the gripping quality is greatly improved and less pressure or strain is required of the set screw. Should the dog be needed for a finished piece of work, a piece of

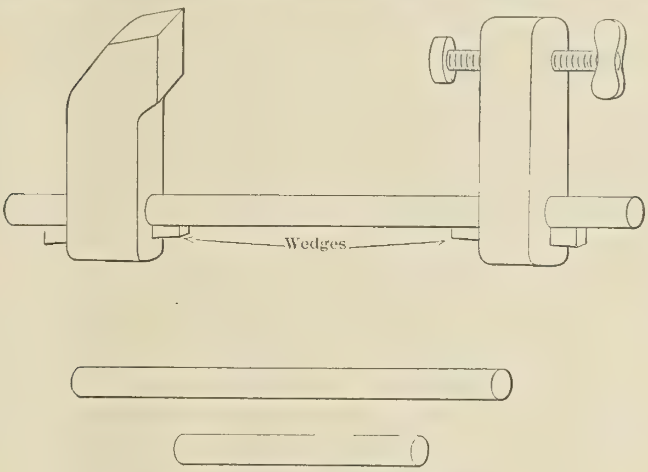


Fig. 4.—Variable Length Bar Clamp

soft brass can be used over the end that enters the dog, the same as when avoiding a set screw impression.

Fig. 3 shows a very good way to make wire cleaning brushes for cleaning the chips out of the slots of the planer, milling machine and shaper, table slots, and for any such work; they are very durable. Short lengths of old small size pipe serve for handles. Two short lengths of ⅜-inch old wire cable are inserted into the end of the

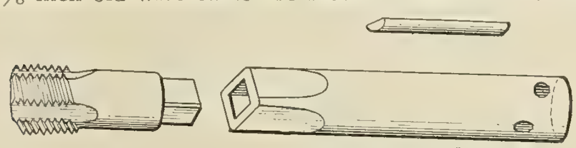


Fig. 5.—Extension Tap Wrench

pipe, and then the end of it is smashed down with a hammer or squeezed flat in a vise, and the cables soldered to the neck as shown. The many strands are teased out to form the brush and are cut even at the ends.

Fig. 4 is termed a variable length clamp; is a very useful tool and quite easily made. The heads or jaws are made from solid bar stock 1½ inches square. The holes for the round bar are of ¾ inch diameter, and at one side of each hole is cut a tapering keyway for the securing wedges shown. This clamp can be adapted to suit a wide range of dimensions, for any length of ¾-inch round bar can be called into use in the jaws.

Oftentimes one has to tap out a pulley, a gear hub or similar part, and the hole is so inaccessible that some extension is required for the tap. I have always had excellent results with the socket extension tap wrench made from pipe, as shown in Fig. 5. Steel tubing is best, if obtainable. Tubing or steel pipe offers a wide variety of sizes from which to make socket wrenches.

Concord, N. H. Chas. H. Willey.

Unique Marine Accident

Extraordinary accidents, due either to human fallibility or to circumstances over which control is difficult to exercise, or imagination to foresee, do happen. Most of these provide a useful lesson, especially where the consequences are fatal or where large sums are involved. A history of industrial accidents would be worth compilation. It would range between unprotected gear wheels and boiler explosions. Every accident, by which term is meant an undesirable happening which takes place against the will and wish of the man in control, has a reason behind it.

Some ship happenings are so mysterious that the charter and bill of lading always exclude liability for act of God, wind or weather, and the consignee finds that this covering clause is made to do duty through a very wide range. As a protest can be sworn before a notary public for a very modest fee, the ship, in the person of her chief mate, contrives most often to escape liability for damages to cargo. Deck cargo, for which the ship invariably disclaims liability, is subject to jettison on very slight provocation. In this case the will of decision of the master is above the law, and for this reason deck cargo is always a considerable risk to the consignor. The intricacies of marine insurance were always puzzling and need a Philadelphia lawyer to unravel, but the ship's master in practice obeys very simple and practical rules in connection with his duties. The substances commonly termed chemicals are first among the slaughter of the innocents, largely because the ship's officers are naturally ignorant of their nature.

The latest accident to a ship, involving her total loss from a combination of circumstances probably unique even in the annals of the sea, was recently given in the daily press. As it serves the purpose of warning, it is worth circulation where it will be seen by those in a position to safeguard risk.

"It was stated at the inquest yesterday that the explosion which wrecked the Grimsby trawler *King Harold* was caused through a drum of calcium carbide being accidentally dropped into the engines, which pounded it to pieces.

"The carbide came in contact with water in the bilges, and the acetylene thus generated exploded, wrecking the ship and killing three men."

Thus the extract from the *London Daily Chronicle* of October 24, 1917.

Familiarity may breed contempt, and those most used to danger are apt to become indifferent through use and habit; still, the fact that a drum of carbide should be so handled or positioned that the accident was possible points a useful warning.

London. A. L. Haas.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

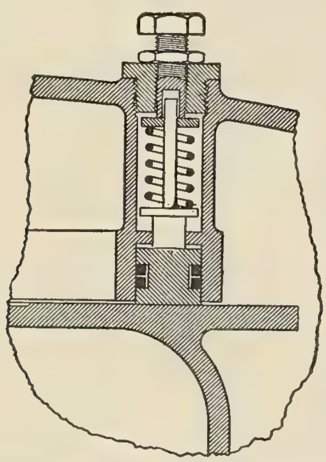
This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number if from examination for grade of chief, and by a dagger (†) if from examination for other grades.

Equilibrium Ring on Flat Slide Valve

Q. (931).—What is the purpose of an equilibrium ring on the back of a flat slide alve, and how is it fitted up?

A. (931).—With large slide valves and where the lubrication is scanty, the frictional forces, due to the steam pressures, exert an unnecessary strain on the eccentrics. As a means of obviating this, equilibrium rings are fitted on the backs of the valves. The function of the equilibrium ring is to prevent excessive pressures on the back



Section Through Equilibrium Ring

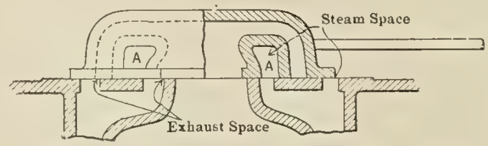
of the valve, and it accomplishes it by making a tight joint with the back of the valve. The space within the ring is connected usually to the condenser. The back of the valve is thus relieved from excessive steam pressure, and, as a consequence, the sliding friction is largely reduced.

Contiguous with the inner face of the valve chest is a grooved ring. A second ring is placed within the first and forced against the back of the valve by means of springs. The back of the valve is faced off to give a running fit between the ring and the valve.

Double Ported Valve

Q. (932).—What is a double-ported valve, and what is the purpose of this style of valve?

A. (932).—Since steam increases rapidly in volume in expanding, the steam ports of the low pressure cylinders of multiple expansion engines are necessarily large. This large port area would require the use of a large eccentric, and, as a consequence, the considerable expenditure of



Section Through Double-Ported Slide Valve

power to work it. To avoid this, a double- or triple-ported valve is employed, the former more generally.

The second, or extra, ports are marked *A*, and steam enters these ports from both sides of the valve.

Remedy for Sediment in Feed Heater Tubes

Q. (936).—What will dissolve sediment which collects in feed heater tubes?

A. (936).—I know of nothing that will be effective for all sorts of sediment that is not injurious to the tubes. A well-operated marine plant should not have much sediment in the tubes, as a filter should be in the line leading to the heater, and the water is practically freed from scale-forming material when it leaves the hot-well. For shore plants the problem is as complex as that of the feed water and needs individual study for each case.

Ratio of Expansion

Q. (935).—What is meant by ratio of expansion?

A. (935).—Neglecting clearances, as is commonly done, the ratio of the volume of the low pressure cylinder to the volume of the high pressure cylinder at cut-off is the ratio of expansion. For example, a compound engine

$$\frac{10 \text{ inches by } 20 \text{ inches}}{12 \text{ inches}}$$

with cut-off at three-fourth stroke, has an expansive ratio of

$$e = \frac{\text{Vol. L. P.}}{\text{Vol. H. P. at C. O.}} = \frac{\dfrac{\pi\, 20^2}{4} \times 12}{\frac{3}{4}\left(\dfrac{\pi\, 10^2}{4} \times 12\right)} = 5\tfrac{1}{3}.$$

The expression

$$e = \frac{\text{Vol. L. P.}}{\text{Vol. H. P. at C. O.}}$$

can be reduced to

$$e = \frac{(\text{L. P. Dia.})^2}{(\text{H. P. Dia.})^2 \times \text{percent C. O.}},$$

for the above case

$$e = \frac{20 \times 20}{10 \times 10 \times .75} = 5.33.$$

A triple expansion engine

$$\frac{19 \times 31 \times 54}{42},$$

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

with a high pressure cut-off at 60 percent of stroke, has an expansive ratio of

$$e = \frac{54^2}{19^2 \times .6} = \frac{2,916}{361 \times .6} = 13.45, \text{ or approximately } 13\tfrac{1}{2}.$$

The ratio of expansion is also called "number of expansions" by many writers.

Capacity of Circular Tank

Q.* (940).—How many gallons of oil will a circular tank 50 inches in diameter and 7 feet 5 inches high contain?

A. (940).—The contents of the tank are

$$\frac{3.14 \times 50 \times 50 \times 89}{4} = 174,700 \text{ cubic inches.}$$

As 231 cubic inches = 1 gallon, therefore 175,000 ÷ 231 = 756 gallons.

Diameter of Donkey Pump to Get Higher Pressure

Q.* (941).—If a donkey pump, having a water end 5 inches in diameter and a steam cylinder 6 inches in diameter and 70 pounds of steam, will pump a pressure of 100.7 pounds, and you wanted to change the water end so as to pump a pressure of 157½ pounds, what diameter of water end would you require?

A. (941).—The force acting on each end must be equal, and as the force on a piston is proportional to the pressure and the square of its diameter, the direct solution is as follows:

$$\frac{(\text{Diameter water end})^2}{(\text{Diameter steam end})^2} = \frac{\text{Pressure on steam end}}{\text{Pressure on water end}}$$

$$\frac{(\text{Diameter water end})^2}{(6)^2} = \frac{70}{157\tfrac{1}{2}}$$

Diameter water end = 4.0 inches.

The same result is obtained by the more detailed method of equating the forces acting on each piston.

Force on water end = Force on steam end

or

Press. × area (water end) = Press. × area (steam end)

$$157.5 \times \text{area water end} = 70 \times \frac{\pi \times \overline{36}^2}{4} = 1,979$$

$$\text{Area water end} = \frac{1,979}{157.5} = 12.58 \text{ square inches}$$

Diameter water end = 4.0 inches.

Cushioning Engine Piston

Q.* (943).—If an engine required more cushion than the lead furnished, the load being right, what alteration in the valve would be required to obtain it?

A. (943).—Shorten the lap on the valve, or, if the cards including that from the other end of the cylinder can stand it, changing the length of the valve rod will accomplish the same purpose—i. e., with a slide valve taking steam on the outside and driven without a rocker, shorten the valve rod to increase head end lead and compression.

Advancing the eccentric will also advance all operations of the valve to occur earlier in the cycle.

Operation of Ship with Air Pump Broken

Q.* (944).—How would you bring a ship into port with the air pump broken down beyond repair?

A. (944).—Cut out the air pump completely and lead the exhaust line from the condenser around the air pump and directly into the hot well. If the pump barrel is not broken, remove all pump valves to give a clear lead through the pump and let the condensate and air take its normal course to the hot well. Operate the circulating pump at a speed sufficient to condense all steam and make sure that the hot well is uncovered to avoid undue pressure on the condenser. You can then operate the engine, but the power will be reduced by the work formerly made available by the vacuum (probably nearly all of the low pressure cylinder) and some vapor will come out into the engine room.

Rules for Fitting Gage Cocks and Safety Plugs

Q.† (945).—What are the rules for fitting gage cocks and safety plugs, and at what temperature will a safety plug melt?

A. (945).—The General Rules and Regulations of the Board of Supervising Inspectors (ocean and coastwise) require all boilers, except flash boilers, shall be supplied with at least three gage cocks attached directly to each boiler. When the gage cocks are connected to the boilers by a water column there shall be three additional gage cocks inserted in the head or shell of boiler. The lower gage cock in boilers more than 48 inches in diameter shall be not less than 4 inches above the top of the flues, tubes or combustion chambers. In boilers less than 48 inches in diameter the lower gage cock shall be not less than 2½ inches above the top of the flues, tubes or combustion chambers.

Double-end boilers shall have at least three gage cocks at each end.

In vertical boilers or boilers of the watertube type the location of the lowest gage cock shall be determined by the local inspectors.

A safety plug should melt at about 450 degrees F.

Inspection of Scotch Boiler

Q.† (946).—You are sent to inspect a Scotch boiler. Explain in detail what you would do.

A. (946).—The boiler should be examined thoroughly inside and outside.

If the boiler is covered, a sufficient portion of the covering should be removed as may be necessary to properly examine the surface. The joints, longitudinal and circumferential, should be inspected, particular attention being paid to the plating.

The internal inspection should consist of an examination of shell, joints and furnaces. The braces should be examined to see that they are of the correct size and in place. The main defects to look for are pitting, corrosion and scale. The internal fittings, such as hydrokimeter, dry pipe, etc., should be noted. A summary of defects most commonly met with is given below:

(1) Deposits of sediment, (2) incrustation and scale, (3) internal grooving, (4) internal corrosion, (5) external corrosion, (6) defective braces and stays, (7) settings defective, (8) furnace out of shape, (9) fracture of plate, (10) burned plates, (11) laminated plates,, (12) defective riveting, (13) defective heads, (14) defective tubes, (15) leakage around tubes, (16) tubes too light, (17) leakage at joints, (18) water gages defective, (19) blowoffs defective, (20) deficiency of water, (21) safety valves overloaded, (22) safety valves defective, (23) pressure gages defective, (24) pressure gages lacking.

Relative Position of Distiller and Evaporator

Q. (951).—Does the vertical position of the distiller in relation to the evaporator have any bearing on its efficincy?

A. (951).—It has no bearing on the efficiency of the plant, but if located fairly high above the distiller pump, that unit operates better mechanically, and also there is less danger of salt water being carried over from the evaporator due to priming.

Shipbuilding and General Marine News

**Contracts for New Ships—Shipyard Improvements—
Engineering Projects—Improved Appliances—Personal Items**

OUTPUT OF MERCHANT TONNAGE FROM AMERICAN SHIPYARDS

American shipyards turned out 901,223 gross tons of merchant vessels in 1917, according to reports made to the Shipping Board. This was nearly double that of 1916, and almost half of the world's output of 1,899,943 tons of that year.

Figures showing the construction in other countries in 1917 are not available, although it is known that English yards are rapidly increasing their output, and Japan has also greatly increased its ship production, although limited by the lack of steel. Other countries are building few ships.

Production in 1918

An output of from 4,500,000 to 5,000,000 tons deadweight is confidently predicted by Chairman Hurley of the Shipping Board for the current year, provided the shipbuilding industry continues to operate on its present basis. This prediction is based on estimates from Lloyd's special agents after a careful survey of the shipbuilding situation of the country last December.

More than 300,000 tons of shipping will be added to the American merchant marine during the first two months of 1918 through the completion of commandeered vessels. During January, 18 vessels, with an aggregate deadweight tonnage of 145,091, are scheduled for completion, and it is expected that 23 vessels, with a total deadweight tonnage of 182,061, will be completed in February. The ships for the most part are cargo vessels and tankers, originally ordered by private owners but subsequently commandeered by the Government.

Shipways Available

When the Emergency Fleet Corporation was organized there were available for merchant shipbuilding in the United States 148 ways. To-day there are available 716 ways finished or under construction; 95 percent of them are completed, and on every way that is ready a keel has been laid.

Approximately 300 ways are for wooden shipbuilding, the remainder for steel. A fair estimate offered by Chairman Hurley of the Shipping Board is that from each wooden shipbuilding way two ships will be turned out in a year, and from each steel shipbuilding way three vessels.

Shipyard Labor Increasing

On October 13 there were employed in 118 shipyards engaged in work for the Emergency Fleet Corporation 105,497 workers. By December 21 this force had increased to 171,274, a gain of 65,777 men, or 62.3 percent.

Reports from 52 steel shipbuilding plants showed a gain in the number of workers employed for this period of 60 percent. These yards employed 93,048 men on October 13 and 148,462 on December 21—an increase of more than 55,000. The other plants reported are wooden shipbuilding yards; their combined forces were increased during this period 81 percent.

Shipping Board Asks for $783,000,000

Requests from the Treasury Department ask Congress to increase by $783,000,000 the estimated appropriations for shipbuilding for the next fiscal year. This sum will bring the total appropriations for shipbuilding next year above $2,000,000,000.

The new estimates include $701,000,000 for ship construction, bringing the total appropriations for that purpose up to $1,935,000,0000, and $82,000,000 for shipbuilding plants, bringing the total for that purpose up to $247,000,000.

Thus far the Shipping Board has been authorized to spend for shipbuilding $1,234,000,000, contracts for most of which have been awarded. The additional appropriations called for will be used largely for additional fabricated steel ship contracts.

Of the $82,000,000 asked for additional shipbuilding plants, about $35,000,000 will be used for housing the workmen at the plants.

Watertube Boilers Recently Approved by the Steamboat Inspection Service

Under the provision of Section 4429, Revised Statutes, the executive committee of the Steamboat Inspection Service has approved the following watertube boilers: Modification of Emergency Fleet Corporation's standard watertube boiler, presented by the Emergency Fleet Corporation, Washington, D. C.; C. H. watertube marine boiler, presented by the Casey-Hedges Company, Chattanooga, Tenn.; Connolly standard watertube boiler of the drum and bent tube type, and the Connolly watertube boiler of the header and straight tube type, presented by the D. Connolly Boiler Company, Cleveland, Ohio; the Wickes marine watertube boiler, presented by the Wickes Boiler Company, Saginaw, Mich.

Other marine appliances recently approved by the Steamboat Inspection Service include the Hill's boat releasing gear, presented by the New York Shipbuilding Corporation, Camden, N. J.; the Aaron fire extinguisher, soda and acid type, 2½-gallon machine, manufactured by the Robinson Fire Apparatus Manufacturing Company, St. Louis, Mo., and valves and fittings manufactured by the Old Dominion Iron Works, Berkeley, Va.; O'Malley-Beare Valve Company, Chicago, Ill, and the Yarnall-Waring Company, Chestnut Hill, Philadelphia.

Appropriations Asked for Navy Increase

In the Naval Bill for this year an appropriation of $212,488,000 is asked for increasing the navy. Provision is made for continuing the three-year programme of ship construction started in 1916. No additional funds are asked for the destroyer programme, which was provided for in an emergency appropriation made during the last session of Congress.

Included in the total appropriation for the increase of the navy is $94,000,000 for aviation and $4,000,000 for the improvement of shipbuilding yards.

Canadian Shipbuilding Programme

Hon. C. C. Ballantyne, Minister of Marine and Fisheries of the New Union Government in Canada, has outlined plans designed to utilize to the fullest capacity Canadian shipyards and to establish rolling mills as essential to that industry. The output of these yards at present may be roughly estimated at from 275,000 to 300,000 tons annually.

The programme, as outlined, calls for an expenditure of from $50,000,000 to $60,000,000 annually for ocean-going cargo vessels, to be built under and operated by the Canadian Government.

Thirty More Lake Steamers to be Placed in Atlantic Service

Thirty large lake steamers, with an aggregate tonnage of more than 100,000, are to be placed in the transatlantic service by the United States Shipping Board as soon as navigation opens in the spring. In all, the Great Lakes will add more than half a million tons to the Atlantic fleet in the spring of 1918.

Vessels building on the lakes for the Shipping Board total nearly 450,000 tons, while forty vessels were brought down from the lakes in 1917, with an aggregate tonnage of 135,000.

Shipbuilding School Opened on Staten Island

In order to assist the United States Government in its shipbuilding programme, the city of New York, through its Department of Education, has opened an evening school for shipbuilders at Public School No. 20, Port Richmond, Staten Island, N. Y. Approximately 5,000 men are now engaged in shipbuilding on Staten Island, and within a year this force must be increased to 12,000 men. The courses offered in the school are planned to be of immediate value to the men now employed in the shipbuilding yards, and also for the training of the new men who are continually going into the yards. The courses offered include a beginners' course for mold loftsmen; an advance course for

mold loftsmen; a beginners' course for ship fitters; a course in blue print reading, layout work and a study of constructional requirements and a course for riveters.

There are three distinct classes of men in the shipyards who need training: First, the men who have been employed in shipbuilding for a number of years who need supplementary instruction in blue print reading, mathematics, layout work and building requirements, so that the men can qualify for positions as foremen and assistant foremen; second, the training of men from allied trades, and, third, the educating of men, such as salesmen, laborers and clerks, without mechanical experience, and training them to do a special type of work in the shipyards. It is to fill this need that the school has been opened.

American Ships Sunk by the Enemy

According to figures carefully compiled and recently published by the *Journal of Commerce*, a total of 79 American vessels of 201,397 gross tons have been sunk by the enemy since the war began, with a loss of 313 lives. A summary of the losses by years is given in the following table:

Year—	Vessels Lost	Gross Tonnage	Lives Lost
1915	7	16,067	4
1916	3	12,426	0
1917	68	170,106	301
1918	1	2,798	8
Totals	79	201,397	313

An inspection of the detailed list of losses shows that since 1915 all sinkings have been caused by submarines with the exception of two schooners, which last June were sunk in the Pacific by a German cruiser. In 1915 five American vessels were lost by striking mines and one was sunk by a raider. A large proportion of the total losses consisted of sailing vessels, 35 out of the 79 vessels lost being sailing vessels.

First Motor Ship Runs 210,000 Miles

Since the end of 1910, and up to the beginning of December, 1917, the little motor ship *Vulcanus*, says The Anglo-Saxon Petroleum Company of England, who are the managers for the owners (the Nederlandsche - Indische Tank Stoomboot Maatschappij), has run 210,000 nautical miles, and her engine is still in good order and condition. In view of the fact that she is a very full-bodied tanker of but 7½ to 8 knots loaded speed, and of only 500 brake-horsepower, this is a very fine record.

She has a beam of 37 feet 9 inches and a length of 196 feet. Her loaded displacement is 2,080 tons, and she has a carrying capacity of 1,235 tons on a draft of 10½ feet, and a daily fuel consumption of fourteen barrels of crude oil fuel. She is fitted with a 6-cylinder, 4-cycle type, 15¾-inch by 23⅝-inch Werkspoor reversible Diesel engine. On a voyage of 66 steaming days her total oil-fuel consumption was 134 tons (938 barrels). On more than one occasion she has run for eighty-eight days without rebunkering, although she only carries less than 200 tons of fuel.

The *Vulcanus* is of interest because she was the first ocean-going, full-powered reversible Diesel-driven ship placed in service. For two years she ran on Taraken crude oil, having a specific gravity of 0.950 at 15 degrees C. On this oil her fuel consumption was guaranteed at 0.42 pound per shaft-horsepower at full load. Her trial speed was 8.4 knots.

New Intensive Naval Architecture Course at the Massachusetts Institute of Technology

Such has been the demand for men conversant with naval architecture, and so instant was the placing of men trained in this specialty on the occasion of the previous course, that the Massachusetts Institute of Technology is offering another course similar to that of six months ago. It will be an intensive course in naval architecture, which will begin February 4 and end about May 24, open to the graduates of technical schools and other persons having the same preparation. This course, under Professor C. H. Peabody, gives a good training in theoretical principles and in ship design, and it goes without saying that there will be a demand for men who show ability in these studies. Students in the course will have the privilege of taking other work at the Institute for which they may be qualified.

Students already registered at the Institute will pay for the special term $25 in addition to the regular tuition fee for the second term. Those who register for the intensive course only will pay full tuition for a term, namely, $150.

The text books required are "Naval Architecture," Peabody, and "Practical Shipbuilding," Holmes, to be obtained at the Technology Branch, Harvard Cooperative Society.

For further information and registration apply to Professor C. H. Peabody, Department of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Concrete Cargo Ships to Be Constructed by the Shipping Board

The Shipping Board, in co-operation with the Bureau of Standards, will undertake the construction of concrete cargo ships. This decision follows an investigation by the Bureau of Standards of the 5,000-ton concrete vessel now under construction at San Francisco. The Shipping Board has already negotiated a provisional contract with Matthew Hale, of Boston, for the construction of twenty concrete ships of 3,500 tons each by a Boston company to be called the Liberty Shipbuilding Corporation. The contract provides that a concrete vessel now under construction by the Boston concern be accepted by the Emergency Fleet Corporation.

In presenting the proposal to the Shipping Board, Mr. Hale represented that the plans of his clients had been approved by marine experts of the Massachusetts Institute of Technology.

The Shipping Board is further considering the construction of concrete barges to be used in the coastwise traffic.

NEWS ITEMS FROM THE SHIPYARDS

Additions and Improvements

New Shipyards Projected

According to report, O'Connor-Bennett, Inc., consulting engineers, 45 East Forty-second street, New York, in cooperation with the Union Dry Dock & Repair Company, Weehawken, N. J., have taken over a large tract of land near Port Jefferson, L. I., with the intention of building a yard for the manufacture of coal barges for the Navy Department. It is reported that an order has already been received from the United States Navy Department to build eight of these barges, each to cost $125,000.

It is reported that the Foundation Company, E. E. Jenkins, purchasing agent, 233 Broadway, New York, which has already established yards in the Hackensack Meadows, Portland, Ore., and Vancouver, Wash., plans the construction of another yard at Seattle, Wash., to have ten ways.

W. H. Garland, 404 Dock street, Wilmington, N. C., president of the International Navigation Company, is reported to be planning the establishment of a shipyard near Southport, N. C.

The Alabama Dry Dock & Shipbuilding Company, E. L. Merkel, Jr., purchasing agent, Mobile, Ala., is planning the erection of a 10,000-ton drydock to be used especially for repairing Government vessels.

The G. M. Standifer Construction Corporation, J. J. Burke, purchasing agent, Portland, Ore., is making plans for a million dollar steel plant, and is reported to have received contracts to build ten steel freight ships for the United States Shipping Board.

It is reported that C. D. Logan, manager of the Rayburn Lumber Company, is planning to build a shipyard at Apalachicola, Fla.

It is reported that Louis Van Horn, Washington, D. C., is planning the erection of a shipyard to build fabricated steel ships for the Government.

Emery M. Newton, 601 Keyser building, Baltimore, Md., is planning to organize a company to erect a shipyard for building steel vessels.

Mayor E. T. Woodman, Los Angeles, Cal., announces that a new steel shipbuilding plant is about to be built at Los Angeles.

The Norway-Pacific Construction & Dry Dock Company, Everett, Wash., M. G. Thomle, president, will, according to report, build a shipyard to be equipped for building both steel and wooden vessels.

The Todd Shipyards Corporation, 15 Whitehall street, New York, has purchased the Puillon Shipyard, foot of Clinton street, Brooklyn, N. Y.

The Houston Shipbuilding Company, Houston, Tex., has been incorporated to build a shipyard. A. D. Boice, Houston, is a stockholder.

It is reported that Henry Ford, the automobile manufacturer, Detroit, Mich., will erect a large shipyard somewhere on the South Atlantic coast to build a special type of vessel for the Government.

The Hydro Barge Company, Penns Grove, N. J., is planning to build a shipyard near Norfolk, Va., for the construction of concrete barges and ships.

The Liberty Shipbuilding Company, Boston, Mass., is planning to build a shipyard near Savannah, Ga.

The Hanlon Dry Dock & Shipbuilding Company, Oakland, Cal., has acquired additional land, and will install machinery to build steel in addition to wooden ships.

It is reported that the Union Construction Company has acquired a site of land in San Francisco Bay, Oakland, Cal., with the intention of building a shipyard.

It is announced that the Norway-Pacific Construction & Dry Dock Company, Seattle, Wash., will construct a ship-building plant at Everett, Wash., at a cost of $1,500,000, to build steel ships.

John L. Hall, Henry building, Seattle, Wash., is one of those who have organized the Lake Washington Shipyards Company.

The Superior Shipbuilding Company, Superior, Wis., is adding three berths to its yards, making a total of seven.

The Mann Shipbuilding Company, Light street, Baltimore, Md., is having plans prepared for a shipbuilding plant on Curtiss Bay.

The San Diego Bay Shipbuilding Company has been incorporated by W. J. Strachan, Carl F. Enper, J. Burris Mitchell and others, all of San Diego.

The Liberty Shipbuilding Company has been incorporated in Boston, Mass. Max Shoolman, 372 Chestnut Hill, Boston, is treasurer.

John F. Craig, Long Beach, Cal., has purchased the plant and Government contracts of the California Shipbuilding Company, Long Beach, Cal.

The old paper-making plant of the Colonial Paper Company, Portsmouth, N. H., has been acquired by the Atlantic Engine & Shipbuilding Company, Boston, Mass. It is said that a shipyard will be erected on this site and that the company will build ten steel ships for the Shipping Board.

The Louisiana Shipbuilding Corporation is the new name of the reorganized Slidell Shipbuilding Company at Slidell, La.

Shipbuilding Contracts

Chairman Hurley of the United States Shipping Board, Washington, D. C., has asked a supplementary appropriation of $484,000,000 for the construction of ships for 1919.

A bill has been introduced into the New York Legislature to appropriate $950,000 for the construction of barge canal terminals at Kingston, Newburgh, Poughkeepsie and Yonkers.

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German Submarine Surrenders to U. S. Destroyer *Fanning*

The Pensacola Shipbuilding Corporation, F. M. Blaunt, general manager and purchasing agent, Pensacola, Fla., is reported to have received a contract from the United States Shipping Board to build ten 9,400-ton steel freight ships.

The Pacific Coast Shipbuilding Company, Mill City, Cal., is reported to have received a contract from the United States Shipping Board to build ten 9,500-ton steel steamships, in a yard to be built at Bay Point, Cal.

The Grays Harbor Shipbuilding Company, W. R. Osborn, purchasing agent, has received a contract from the United States Shipping Board to build four wooden freight ships of 4,000 tons each.

The Bayles Shipyard, Inc., Port Jefferson, L. I., L. Deyo, purchasing agent, 115 Broadway, New York, has a contract from the United States Shipping Board to build four steel steamships.

The United States Shipbuilding Company, San Diego, Cal., is reported to have received a contract from the United States Shipping Board to build eight steel steamships of 8,800 tons each.

The Peninsula Shipbuilding Company, H. H. Fisher, purchasing agent, Portland, Ore., has contracts from the United States Shipping Board to build six or more wooden steamships, in addition to the eight vessels, contracts for which have already been reported.

Babare Bros., Tacoma, Wash., have received a contract from the United States Shipping Board to build two wooden steamships of 3,500 tons each.

The Moore & Scott Iron Works, T. G. Otis, purchasing agent, Oakland, Cal., are reported to have received a contract from the United States Shipping Board to build ten 9,400-ton freight steamships and six 10,000-ton oil tank steamships.

The McAteer Shipbuilding Company, O. J. Ramm, purchasing agent, Seattle, Wash., is reported to have received contracts to build two wooden freight ships for Norwegian interests.

The New Jersey Dry Dock & Transportation Company, Patrick Higgins, president, Elizabethport, N. J., is building two steel tugs for the Central Railroad of New Jersey, 143 Liberty street, New York, and one steam lighter for the Lehigh Valley Railroad Company, 143 Liberty street, New York.

Frank C. Adams, East Boothbay, Me., is building a 152-foot wooden auxiliary three-masted schooner from designs by John G. Alden, of Boston, Mass.

William H. Baldwin, New Baltimore, N. Y., is building a 65-foot wooden tug for the Red Hook Towing Company, Brooklyn, N. Y.

E. James Tull, Pocomoke City, Md., is building two wooden barges for the Diamond P. Barge Line, Philadelphia, Pa.

The International Marine Iron Works, Houston, Tex., has a contract, said to amount to $2,500,000, with the International Shipbuilding Company to equip with machinery the ships which the International Shipbuilding Company is building in its yards at Gulfport and Pascagoula, Miss., and Orange, Tex.

H. D. Cabell, vice-president of the Clayton Ship & Boat Building Corporation, Clayton, N. Y., announces that his company has decided to build four barges of 750 tons capacity for traffic on the New York State Barge Canal, and that it is planning to build a large number of additional barges for concerns now in course of organization.

Charles W. Morse, 50 Broad street, New York, who has recently organized the American Shipbuilding Company, with a site on the Potomac River at Alexandria, Va., is reported to have received a contract from the Shipping Board to build twelve 8,800-ton steel ships.

The York River Shipbuilding Corporation, Ripley Bowman, purchasing agent, West Point, Va., has received a contract from the Shipping Board to build eight wooden hulls of the Ferris type. These boats will each have a net tonnage of 3,500 tons.

The Standifer Shipbuilding Company, Portland, Ore., is reported to have received contracts from the U. S. Shipping Board Emergency Fleet Corporation to build ten 8,800-ton steel vessels. It is also reported that the company has secured a site of land for an additional shipbuilding plant at Vancouver, Wash.

Capt. D. M. Swain, Stillwater, Minn., has placed a contract to build thirty-six barges and two tugs.

The Greenwich Piers Marine Railway Company, Greenwich Piers, N. J., is building a wooden tug for Gayley, Davis & Company, Philadelphia, Pa.

The Lake Erie Dry Dock & Engineering Company, Sandusky, Ohio, is reported to have received a contract from the Shipping Board to build ten 260-foot steamships.

The Memphis Steel Construction Company, Memphis, Tenn., has received a contract from the War Department, Washington, D. C., to build a steel barge.

The Dravo Construction Company, Wheeling, W. Va., has secured a contract from the War Department to build seven motor boat hulls.

Electric Mono-Rail Hoists for Handling Ashes

When up-to-date boiler houses are designed, the problem of handling the ashes is now always considered. A mono-rail electric hoist, with a bottom dumping bucket, as illustrated, which is

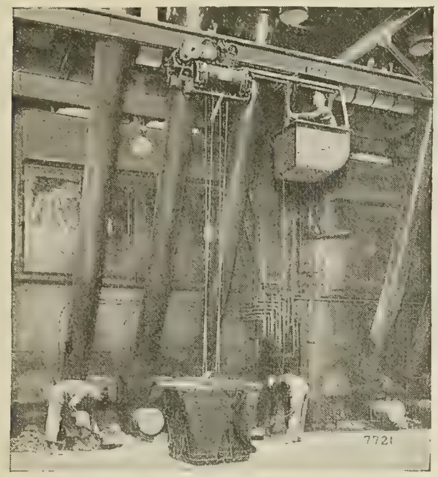


Fig. 1.—Machine in the Boiler House

manufactured by the Link-Belt Company, Chicago, Ill., is a type of machinery which lends itself readily to such installations. This is especially true where the ashes are pulled out on the boiler room floor, which is so often the case.

This machine runs on the lower flange of an I-beam track. It is operated by a man traveling in a trailer cage, who controls the raising or lowering of the bucket as well as the travel hoist. Fig. 1 shows the machine in the boiler house through which the track runs and continues on out over a railroad siding, as shown in Fig. 2.

The laborers who clean the fires fill the bucket with ashes. The operator

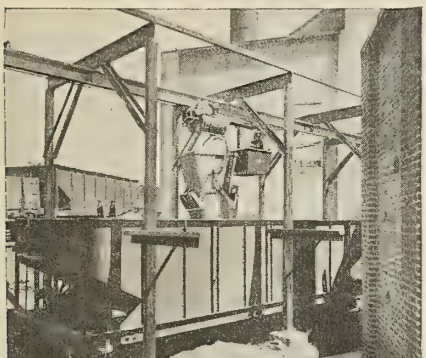


Fig. 2.—Dumping Ashes in Railroad Car

then hoists his bucket and runs it out directly over the car, where he dumps it by the motion of a lever in the cage. The current required is very small. By comparing this method with that of wheeling ashes, a marked saving in time will be apparent.

In many installations where an overhead bin or suspension bunker cannot be installed, on account of lack of space, for supplying coal to the stokers, it may then be practicable to use the same mono-rail hoist system to handle the coal as well as the ashes. Fig. 3 shows a tipping bucket about to discharge coal into a stoker hopper. Better even than this, a bucket with a small chute and undercut grate is often used.

This problem of handling ashes mechanically is daily becoming more urgent. Many boiler rooms are now running 24 hours a day where two years ago they were running ten—hence over twice the ashes to handle and with labor so scarce.

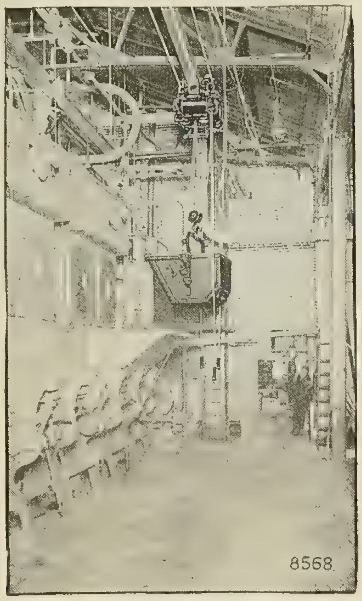


Fig. 3.—Coaling Boilers with Tipping Bucket

Many plants have put in stokers and forced draft systems to increase their capacity, often neglecting to provide for the handling of the ashes when the remodeling is done. The electric hoist fills a long-felt want in this field.

Students in Shipping Board Schools Exempted from Military Duty

Official announcement was made January 19 by Henry Howard, Director of Recruiting for the United States Shipping Board, that under a recently issued regulation of the Provost Marshal General's Department all students entering Shipping Board schools for deck officers or engineers, will be exempted from military duty, and will remain exempted so long as they pursue the calling for which the school fits them. This affects six hundred or more students now in Shipping Board schools, and will apply to students enrolled in the future.

There are now thirty of these schools training deck officers for the merchant marine and eight training engineers. Only men who have had two years' seafaring experience are admitted to the schools. About four thousand new officers for the merchant marine have been licensed since the United States entered the war.

More Ships Traversing the Panama Canal

Traffic through the Panama Canal last year increased largely over the previous years, according to the annual report of Col. Chester Harding, governor of the canal. A total of 1,876 vessels of all classes passed through the canal from July 1, 1916, to June 30, 1917, inclusive.

Of these, 905 passed from the Atlantic to the Pacific, and 971 from the Pacific to the Atlantic. In the fiscal year 1915, 1,088 vessels passed through the canal, and in 1916, 787. The total number of vessels transiting the canal since it opened for commercial traffic in August, 1914, is 3,751. The total net tonnage, canal measurement, for the several years is as follows: 1915, 3,849,035; 1916, 2,479,762, and 1917, 6,009,358. The cargo tonnage transported was, for 1915, 4,969,792; 1916, 3,140,046, and 1917, 7,229,255.

Scarcity of Skilled Labor

Unusual difficulty was experienced in securing an adequate supply of skilled mechanics in the United States for duty on the Isthmus, especially in the shipbuilding and repairing trades, due to the abnormal activities in the various manufacturing plants and shipyards. Fifty-four percent of those tendered employment failed to accept, as against 48 percent during the preceding fiscal year.

Ship Draftsmen Are Needeed for Emergency Fleet Work

The Civil Service Commission issues the following:

There are not enough ship draftsmen in the United States to do the drafting work needed to carry out the naval and merchant shipbuilding programmes. Our country is engaged in the execution of the greatest warship construction plan in history, comprising 787 vessels, including all types from superdreadnaughts to submarine chasers. Naval appropriations aggregating nearly two billions of dollars have been made since August, 1916.

Technical Men Needed

Coincident with the demand for increased naval work there is an equally urgent call for an increase of merchant ship construction. It is betraying no secret to say that in both branches there is a shortage of technical men available for the work.

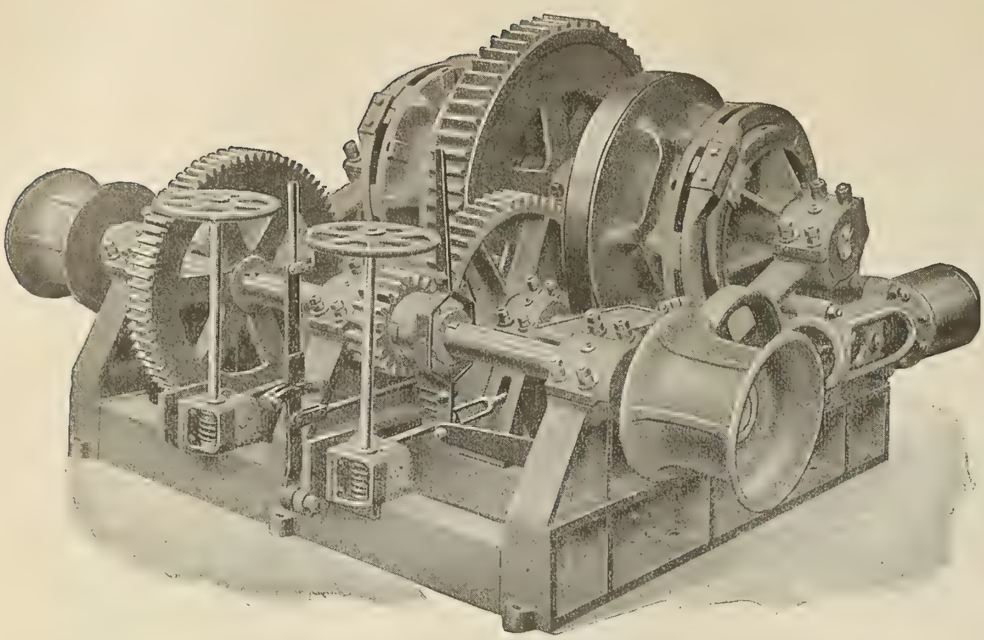
The United States Civil Service Commission is endeavoring to relieve the dearth of ship draftsmen by recommending to the heads of colleges and technical schools that senior students in engineering courses be given intensive training in naval architecture during the coming spring, with a view to making them available for employment as ship draftsmen in June. The Commission is also receiving applications from qualified architectural, mechanical and structural steel draftsmen, and is certifying them for employment in the Navy Department and in navy yards on ship work.

Not Required to Appear

Local boards of civil service examiners at the post offices in all of the larger cities are furnishing detailed information and application blanks. Applicants are not required to appear in an examination room, but are rated upon their education, training and experience.

Women Eligible as Ship Draftsmen in Navy Yards

Women can now help design ships for the United States Navy. They are eligible for employment as ship draftsmen in the navy yard service and mechanical, marine, engine and boiler draftsmen in the Navy Department. The increased needs of service caused by the war have thrown these positions open to them.



8¼-Inch by 10-Inch Mundy Windlass

How the J. S. Mundy Hoisting Engine Company is "Doing Its Bit"

In the construction of the ships for the Emergency Fleet, auxiliary equipment is as essential as the propelling machinery. Of particular importance is the machinery for steering by power, for hoisting anchor, for loading and unloading of cargo and for rapid handling of lines and hawsers. In this field the products of the J. S. Mundy Hoisting Engine Company, of Newark, N. J., have gained for themselves a foremost reputation among shipbuilders and owners. For over forty years this firm has been engaged in the manufacture of cargo hoists, winches and general hoisting and conveying machinery, being the originators of the cone friction drum now universally used on hoisting engines. In recent years it has also turned out many examples of up-to-date windlasses, steering engines and capstans.

Of particular interest at the present time are six vertical capstan windlasses recently built for use on United States submarines. These machines are constructed throughout of steel and bronze castings, a special manganese bronze being used, insuring great strength and avoiding all danger of corrosion. They will be driven through worm gearing by electric motors, and are arranged so that all operations are controlled from inside the hull. The chain wildcat and capstan barrel are on a vertical shaft passing through the hull, and may be unshipped when required, leaving the superstructure flush.

There has recently been completed six complete outfits for vessels of an American steamship company, each comprising a 7-inch by 10-inch steering engine of the drum type, a spur-geared windlass, with 8¼-inch by 10-inch engines, capable of handling 1¾-inch chain, and a hand steering gear of the right and left screw type. For handling cargo each ship will be supplied with six 8¼-inch by 10-inch winches.

This firm has recently supplied thirty-six winches to a shipyard on the great Lakes, twenty-two of the same type being placed on a large Atlantic freighter. They are also building for a steamship company of New York ten special winches, also fifty-five winches and twenty ash hoists with automatic stop for a yard on the Delaware. At present they have under construction for ships now building for Norwegian interests two windlasses for 2¼-inch chain, driven by 9-inch by 10-inch engines, also ten screw gear hand steerers.

Last year the Mundy Company furnished to the Navy Department two vertical capstan windlasses to be placed on vessels at Mare Island, Cal. These are driven through steel worms and bronze gears by engines hung on the underside of deck.

There is also being built for an Atlantic steamship company one of the largest size horizontal windlasses to handle 2¼-inch chain, and driven by 10-inch by 10-inch engines. For the same vessel there is also being supplied a 9-inch by 10-inch steering engine of the screw gear type, with hand steering attachment, and arranged for control either by telemotor or by hand, also nine 9-inch by 10-inch cargo winches.

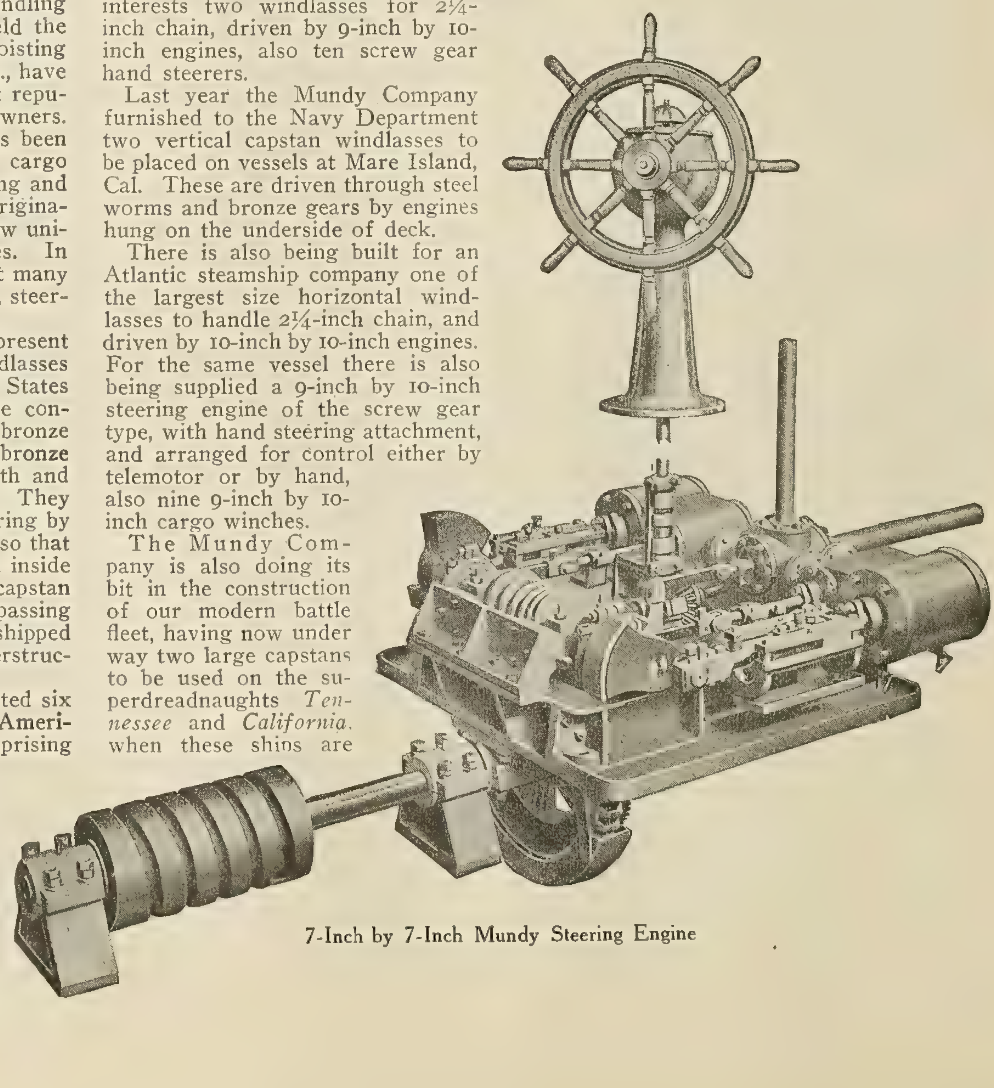
The Mundy Company is also doing its bit in the construction of our modern battle fleet, having now under way two large capstans to be used on the superdreadnaughts *Tennessee* and *California*. when these ships are completed. These machines are built throughout of steel castings of massive construction. The barrels will be located on the afterdeck, and will be driven by 45-horsepower General Electric motors two decks below. The gearing is so arranged that two speeds may be obtained without altering the motor speed.

Another interesting installation is three 45-horsepower electric deck winches being supplied for the battleship *New Mexico*. These winches will be located in front of the forward turret and will have all gearing totally enclosed. The Mundy Company are also supplying the fire-room hoists for the same ship.

For export trade there is now building a 25-horsepower electric windlass and three electric winches, these being to the order of interests in the Dutch East Indies.

The Department of Commerce has recently placed an order for a gasoline (petrol) hoist fitted with a 12-horsepower Fairbanks engine for use in the United States Lighthouse Service.

The Mundy Company are fortunate at this time in having recently moved into their new and modern plant located on the Pennsylvania Railroad, and with their up-to-date equipment and years of experience, may be expected to add to their enviable reputation in the line of hoisting and marine machinery.



7-Inch by 7-Inch Mundy Steering Engine

Bush Piers Requisitioned by the War Department

The War Department, through the Acting Quartermaster-General, has requisitioned the Bush Terminal piers and warehouses in New York City. Of the piers and warehouses available on the Atlantic seaboard the Bush piers are regarded as the best for the purposes of the War Department.

American Ships and Cargoes Insured for More Than a Billion Dollars by the Government

Secretary McAdoo announces that the Bureau of War Risk Insurance, since its creation on September 2, 1914, to December 31, 1917, had issued insurance on the hulls and cargoes of American vessels of more than $1,000,000,000.

The total number of policies written was 13,844. The total premiums received by the Government have exceeded the total losses by $12,888,420.86.

Free Classes in Navigation Established in New York City

Two free classes in navigation for the training of qualified seamen for officers in the new American merchant marine will be conducted in New York throughout the winter by the United States Shipping Board Recruiting Service.

There will be seventy-five students to begin with in each class. The first class was opened December 1, at the Seamen's Church Institute, 25 South street, under the direction of Capt. Robert Huntington. The second class was opened December 15, under the direction of Capt. Fritz E. Uttmark, at 8 State street.

American citizens, 19 to 55 years old, having good vision and hearing and a working knowledge of arithmetic, will be accepted for either class on evidence of two years' experience at sea. The school term for each class will be from four to six weeks, according to the student, who, on graduation, will go before the local inspectors of steam vessels for his examination for a license.

Army Transport Meade Becomes Training Ship for Merchant Marine Apprentices

Announcement was made on January 23, at national headquarters of the United States Shipping Board Recruiting Service at the Boston Custom House, that the army transport *Meade,* formerly the Atlantic liner *City of Berlin,* has been assigned by the Shipping Board to the recruiting service for use as a training ship for apprentices in the American merchant marine. Headquarters for the training service are at Boston, where two training ships are already stationed, the *Calvin Austin* and the *Gov. Dingley.*

The *City of Berlin* was built at Greenock in 1874, and was famous as an Atlantic liner for nearly a generation thereafter. She held the transatlantic records, east and west, between Queenstown and New York, in 1875, her eastbound record being seven days, 15 hours and 48 minutes.

Taken by the United States Government in 1898, and renamed the *Meade,* she was used as a troopship in the Spanish war, and thereafter was more or less steadily employed as a transport until about seven years ago. Although laid up for the last seven years, she ship is reported to be in excellent condition. Her hull is sound and tight, and the repairs the vessel needs are chiefly to her upper works. Probably a month will be required in making these repairs, after which the ship may be used for receiving apprentices at Newport News before being transferred to the training station at Boston.

Seattle Establishing Shipbuilding Records

During the last two months of 1917 the combined shipbuilding plants in Seattle launched ten steel vessels with a total tonnage of 89,800, and two wooden vessels with a total tonnage of 5,000, or a total tonnage of 94,800 tons for the two months.

The largest vessel ever built on the Pacific Northwest coast is the steel steamship *Luckenbach,* recently launched by the Seattle Construction & Dry Dock Company.

Personal

Stanley P. Stewart, mechanical engineer Stewart Boiler Works, Worcester, Mass., has been appointed assistant to the superintendent of the Machinery division of the American International Shipbuilding Corporation, Philadelphia, Pa.

Joseph T. Martin, superintendent of the Sparrows Point plant of the Bethlehem Steel Company, has resigned to become general manager of the Hog Island shipyard, Philadelphia, Pa.

Frederick W. Wood has retired as general manager of the Sparrows Point (Maryland) plant of the Bethlehem Steel Company. Mr. Wood has been continuously engaged in the manufacture of steel and of shipbuilding for forty years, and has been chief executive of the great Sparrows Point plant since it was started in 1887. Mr. Wood will still be connected with the Bethlehem Steel Company in an advisory capacity, but will be succeeded by W. F. Roberts, of Bethlehem, as general manager of the corporation.

Peter Doig, formerly with the firms of Brown, Clydebank; Beardmore's, Dalmuir; Shanghai Dock & Engineering Company, Shanghai, China, and Fore River Shipbuilding Corporation, Quincy, Mass., has been appointed general secretary of the Association of Engineering and Shipbuilding Draftsmen. The headquarters of this organization at present are in Glasgow, but will shortly be transferred to London.

D. M. Callis, formerly chief hull draftsman of the Seattle Construction & Dry Dock Company, Seattle, Wash., is now technical adviser for the United States Shipping Board, Northwest District, stationed at Seattle.

J. K. Ingham has been appointed chief hull draftsman of the Seattle Construction & Dry Dock Company, Seattle, Wash., vice D. C. Callis, resigned.

P. S. Stone, formerly inspector for the Navy Department, Bureau of Construction and Repair, stationed at the Seattle Construction & Dry Dock Company, Seattle, Wash., has been appointed naval architect of the Patterson-McDonald Shipbuilding Company, of Seattle.

Lloyd J. Wentworth, president of the Portland Lumber Company, has been appointed head of the newly created Oregon district of the United States Shipping Board Emergency Fleet Corporation.

Stanton H. King, of Boston, founder and head of the Sailors' Haven at Charlestown, Mass., has been appointed official chantie man for the American merchant marine.

C. P. Coleman was elected president of the Worthington Pump & Machinery Corporation, New York, on December 31.

Frank J. Foley, manager of the mining section of the Industrial Department of the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., has accepted a position as manager of the Mining and Traction Department of the Edison Storage Battery Company, Orange, N. J.

Guy E. Tripp, of New York, chairman of the Westinghouse Electric & Manufacturing Company, has been appointed by the War Department as chief of the production division of the Ordnance Department, entrusted with the task of supervising and stimulating the production of all ordnance supplies. The appointment of Mr. Tripp is one of the important steps in the reorganization of the Ordnance Bureau announced recently by its chief, General Crozier. The board of directors of the Westinghouse Company has given Mr. Tripp a leave of absence for the duration of the war.

H. A. Hornor, electrical engineer of the New York Shipbuilding Corporation, Camden, N. J., has tendered his resignation, to take effect on February 1. Mr. Hornor has been connected with the New York Shipbuilding Corporation for seventeen years. He is chairman of the marine committee of the American Institute of Electrical Engineers, and a frequent contributor to the engineering press on subjects dealing with practical engineering features connected with the applications of electricity to the building and navigating of ships.

Rear Admiral R. S. Griffin, U. S. N., chief of the Bureau of Steam Engineering, has been reappointed as engineer-in-chief of the navy for another term of four years.

Capt. C. W. Dyson, U. S. N., of the Bureau of Steam Engineering of the Navy Department, has been promoted to the rank of rear admiral.

John F. Coleman, consulting engineer, New Orleans, La., has become chief engineer for the shipyards being constructed by the Tennessee Coal & Iron Company at Mobile, Ala.

W. B. Fortune, famed for his work in connection with the Quebec Bridge, has been retained in connection with ship construction at the Hog Island yard of the American International Corporation, Philadelphia, Pa.

Obituary

Thomas G. Mitchell, Lloyd's surveyor in British Columbia, died recently at his home in Vancouver, B. C.

Edward Everett Roberts, inventor of the Roberts marine watertube boiler and founder of the Roberts Boiler Company, Redbank, N. J., died recently at his home in Brooklyn, N. Y., at the age of 76. During the Civil War Mr. Roberts served for three years as engineer officer with Admiral Farragut's fleet, and for the last year of the war with Admiral Porter in the South Atlantic squadron, acting as chief engineer of the flagship *Colorado,* with the rank of captain.

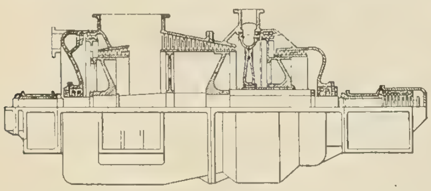
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,235,936. STEAM TURBINE. JAMES C. SHAW, OF PHILADELPHIA, PA., ASSIGNOR TO THE WILLIAM CRAMP & SONS SHIP & ENGINE BUILDING COMPANY, A CORPORATION OF PENNSYLVANIA.

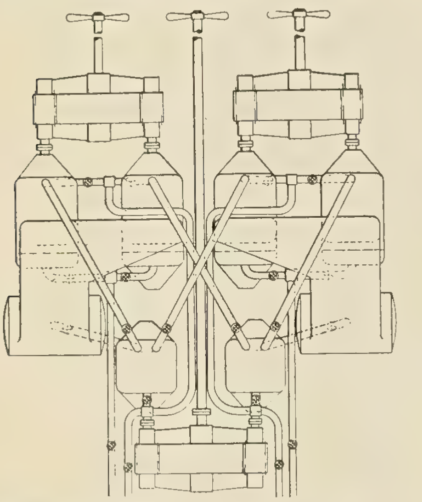
Claim 1.—In a marine steam turbine comprising a shaft carrying a propeller and opposed pressure staged drums having a resultant opposite to the propeller thrust, a single diaphragm between said drums and a compound velocity stage carried by one of said drums adjacent to said diaphragm for effecting a drop in the effective pressure before it



is applied to the drum head and initial drum stage, a live steam inlet close to said diaphragm at one side thereof and a steam conduit from the same side of said diaphragm beyond the drum on that side to the diaphragm at a point close thereto. Nineteen claims.

1,235,937. MARINE TURBINE PROPULSION. JAMES C. SHAW, of PHILADELPHIA, PA., ASSIGNOR TO THE WILLIAM CRAMP & SONS SHIP & ENGINE BUILDING COMPANY, A CORPORATION OF PENNSYLVANIA.

Claim 1.—In a marine turbine installation, a high pressure turbine comprising two intergeared high pressure units, a low pressure



turbine comprising two intergeared units respectively in series therewith, and propelling means driven by said high and low pressure turbines. Thirty-four claims.

1,222,867. VESSEL BULKHEAD. ARCHIBALD HOGG, OF WALKER, NEWCASTLE-UPON-TYNE, ENGLAND.

Claim 1.—A bulkhead construction for ships comprising a transverse bulkhead formed of flat and curved plates disposed so that the curves of adjacent plates are reversed, the flat plates lying at the edges of the bulkhead parallel with the crests and valleys of the curved plates, the arc of each plate curve being limited in extent to not more than one-third of a circle and the width distance between adjacent curve crests exceeding four times the depth distance from crest to reversed crest, flanged joints between said flat plates and curved plates, and a continuous four-sided boundary frame comprising at least one angle bar, two sides of said frame being formed with broad shallow undulations which enter the undulations of the curved plates of the bulkhead, said frame being attached on all four sides both to the bulkhead and to the hull of the ship, all as set forth in the specification. Six claims.

1,223,319. FLYING-BOAT HULL. GLENN H. CURTISS, OF BUFFALO, N. Y., ASSIGNOR TO CURTISS AEROPLANE AND MOTOR CORPORATION, A CORPORATION OF NEW YORK.

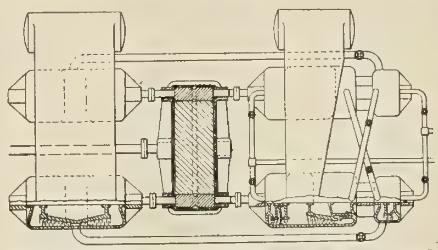
Claim 1.—In a hull for flying boats, a hydroplaning bottom, and fin excrescences formed by extending the bottom planking laterally beyond the chines of the boat body proper. Twenty-two claims.

1,236,539. MEANS FOR LOCATING AND SECURING SUNKEN VESSELS TO HOISTING APPARATUS. THOMAS J. CAHILL, OF SAN FRANCISCO, CAL.

Claim 1.—In combination, a pair of flexible members, one presenting a link through which the other flexible member passes, a crossbar carried by said other flexible member for engaging the link, a hook connected to said other flexible member, floats associated with said hook for maintaining the hook in an upright position in water, a buoy, a flexible member connecting the buoy to the hook, a chain link carried by said flexible member, and a severable member connecting said links to the buoy. Three claims.

1,235,928. COMPOUND GEARED TURBINE. JAMES C. SHAW, OF PHILADELPHIA, PA., ASSIGNOR TO THE WILLIAM CRAMP & SONS SHIP & ENGINE BUILDING COMPANY, A CORPORATION OF PENNSYLVANIA.

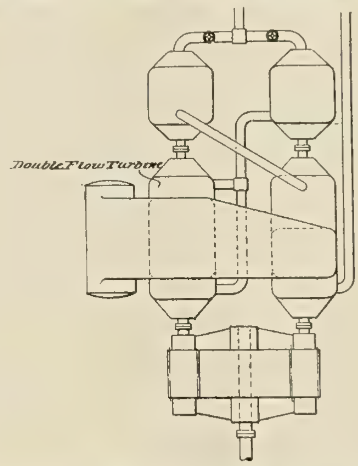
Claim 1.—In a marine turbine installation, a plurality of high pressure units adapted to operate in parallel, a plurality of low pressure



units supplied by each high pressure unit, said high and low pressure units being geared to a propeller shaft, and means for variably cutting out said low pressure units to obtain powers between one-half and seven-eighths. Twenty-four claims.

1,235,939. COMPOUND GEARED TURBINE. JAMES C. SHAW, OF PHILADELPHIA, PA., ASSIGNOR TO THE WILLIAM CRAMP & SONS SHIP & ENGINE BUILDING COMPANY, A CORPORATION OF PENNSYLVANIA.

Claim 4.—In a marine turbine installation, a plurality of shafts each having a high pressure unit and a low pressure unit, a propeller shaft geared to both of said shafts, means connecting the low pressure unit on each shaft in series with the high pressure



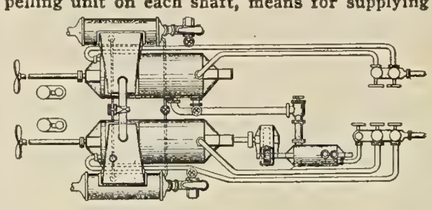
unit on the other shaft, said respective high and low pressure turbines passing predetermined portions of the total fluid pressure at equal speeds of revolution, and means for obtaining reduced power by cutting out one of said high pressure units and its connected low pressure unit. Twenty-three claims.

1,235,991. MARINE PROPULSION. JOHN F. METTEN, OF PHILADELPHIA, PA., ASSIGNOR TO THE WILLIAM CRAMP & SONS SHIP & ENGINE BUILDING COMPANY, A CORPORATION OF PENNSYLVANIA.

Claim 1.—In a marine steam turbine installation, separated forward and after engine rooms, the forward engine room containing main geared units, wing shafts driven respectively by said units, the after engine room doing away with the strains due to the recontaining main geared turbines, center shafts driven by said last mentioned turbines respectively, means for disconnecting the forward main units at the after engine room, high pressure turbines, and means for connecting said wing shafts to be driven by said high pressure turbines. Seventeen claims.

1,235,990. SYSTEM OF MARINE STEAM TURBINES. JOHN F. METTEN, OF PHILADELPHIA, PA., ASSIGNOR TO THE WILLIAM CRAMP & SONS SHIP & ENGINE BUILDING COMPANY, A CORPORATION OF PENNSYLVANIA.

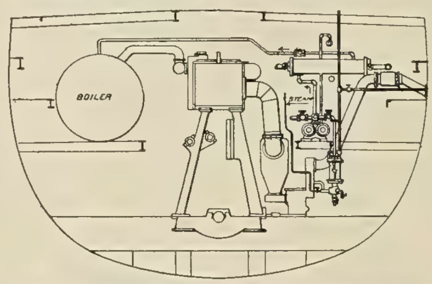
Claim 1.—In a marine propulsion arrangement, a plurality of shafts, a full power propelling unit on each shaft, means for supplying



power to said units for full power, a high speed cruising unit geared to one of said shafts, and means for passing the exhaust from said high speed cruising unit to the full power unit on the other shaft to produce approximately equal powers on said shafts for cruising speed. Eight claims.

1,238,187. FEED WATER HEATING APPARATUS. ERNST PELTON AND STANLEY D. HOPTON, OF GENEVA, OHIO.

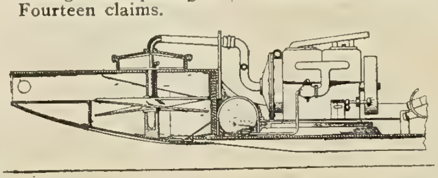
Claim 1.—In an installation, a steam engine having an exhaust pipe, a condenser open to said exhaust pipe, a stand pipe constituting a discharge connection for the condenser, feed



water connections open to said discharge connection and a feed water heater therein below the normal head of water in the stand pipe, said heater having a steam jet arranged to discharge into the water and provided with a separate vapor and water outlet connections. Three claims.

1,238,408. PNEUMATICALLY PROPELLED HYDROPLANE. RAY E. KELLOGG, OF LOS ANGELES, CAL.

Claim 3.—In a hydroplane, a substantially rectangular shaped hull having a bottom wall upturned at its forward end to provide a bow and having its side walls projecting below the bottom wall rearwardly of such upturned end and formed with a transverse opening adjacent the juncture of the upturned end with the remaining portion of the bottom wall, and means for forcing air through the transverse opening for propelling the hull, said means including a cylindrical well formed in the hull adjacent the bow, a hood covering the well and extending flush with the bow throughout the entire width of the hull and open at its forward end throughout the entire width of the hull, and a fan propeller mounted in the well to draw air through the hood and discharge it through the opening in the bottom of the hull. Fourteen claims.



1,237,393. APPARATUS FOR CONTROLLING THE RUDDERS OF SUBMARINES AND OTHER VESSELS. EUGENE SCHNEIDER, OF LE CREUZOT, FRANCE.

Claim 1.—The dependence between the power steering control and the axiometer pointer, which is one of the essential characteristic features of this invention, renders the power steering apparatus completely reversible and allows the rudder to become a motor when struck, for instance, by a heavy sea.

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Volunteer Now!

The Badge of Honor

NO service, save actual military service at the front, can be rendered to the nation that is greater than work in the shipyards. The Shipping Board has the money, the materials and the yards to carry out the gigantic shipbuilding programme to which it is pledged, but it needs men to build the ships. On this one factor alone—ships and more ships—rests the effectiveness of every other effort of the United States in the great war.

Just because you have never worked in a shipyard is no sign that you cannot become an efficient shipyard worker. Shipbuilding calls for the special application of over a score of ordinary trades. Proficiency in any one of these trades will make you a valuable asset to the Government for shipbuilding.

Volunteering for this work now does not mean that you must immediately give up your regular job and begin work at once in some distant shipbuilding city. The volunteers will be held in reserve and called for a few at a time as the need for their services develops.

Shipyard work means a generous wage and none of the hardships and privations which must be borne in military service. Volunteer now and earn the right to wear the badge of honor which is the privilege of every United States Shipyard Volunteer.

Encouragement for the Juniors

H. L. ALDRICH, associate member of the Council of the Society of Naval Architects and Marine Engineers, has offered the sum of $100 (20/16/8) as a prize for the best paper written by a junior member of the Society for its annual meeting in November, 1918. The papers must deal with some phase of shipbuilding or marine engineering, either merchant or naval, and all papers must be completed and delivered to the secretary of the Society on or before October 15, 1918.

This prize has been offered to arouse the interest of the younger members in the activities of the Society and to give them an opportunity to develop their ideas regarding the work which they have adopted as a profession. The merits of the papers will be judged by the members of the Society's Committee on Papers, who will have the right to give the whole sum donated as a prize to the author of the best paper submitted or to divide the sum into two, or even three, prizes, as may seem best, depending upon the quality of the papers submitted.

With this opportunity to gain recognition, the junior members of the Society will have a definite object in following closely the designs and details of ships and shipbuilding, as well as developing ideas of their own for improving such work.

More Meddling

IF the Shipping Board finds it necessary to invoke the aid of another branch of the Government to investigate work which is being carried out under the supervision of its subsidiary corporation, who is at fault? Is this an admission that the Emergency Fleet Corporation is unable to handle its own contracts? The Emergency Fleet Corporation placed the contracts for the construction of the three great government shipyards and is paying for the work out of public funds. If any of the contractors are at fault, isn't this a late hour to discover the difficulty?

If the investigation does nothing else, and we hardly believe it will, it may bring home to the public a better realization of the gigantic undertaking which the Government has embarked upon and of the tremendous difficulties which must be overcome to bring the work to a successful conclusion within the time allotted for it. Delays incident to severe winter weather and transportation difficulties cannot be overcome without excessive expenditures. In the present crisis the main question is, will the work be done on time?

An Heritage of the War

IN years past engineering developments in shipbuilding have, as a rule, progressed slowly, but it has remained for a world-wide war, with its waste of the world's shipping, to bring into general use some of the most radical developments in shipbuilding and propulsion. As an heritage of the war we have the change of shipbuilding to a manufacturing process, with its increased rate of production, the substitution of structural shapes and plates for shipbuilding materials, the general adoption of watertube boilers and geared turbines for cargo vessels, and the wider use of superheated steam. While necessity has led to the application of available resources to the problem of shipbuilding, nevertheless few of the innovations are likely to be immediately discarded when the period of reconstruction begins after the war, and their influence must be reckoned with in future construction. Above all, neither then nor now must the question of economy of steamship operation be ignored, for a pound of fuel saved will always mean that one pound more of cargo can be transported.

WORKERS FOR THE SHIPYARDS

Strike a Blow at the Kaiser by Helping Build a Ship

The Man of the Hour

(Copyright by Press Illustrating Service, N. Y.)

Enrolling Men to Build the New United States Merchant Marine

Workers for the Shipyards

The Paramount Need of the Hour—The Workers Over Here and the Boys Over There, All Dependent Upon Ship Production

BECAUSE ships are the primary factor in the winning of this war, and because the construction of these ships depends, and will always depend, upon labor, there has been created an organization of workmen known as the United States Shipyard Volunteers, enrolled under the Public Service Reserve. This organization is composed of workmen who are willing to give a good day's work for a good day's pay; workmen who are not asked to

(Copyright by Committee on Public Information)

Drillers and Calkers at Work

(Copyright by Committee on Public Information)

Ship Fitters Erecting Frames

sacrifice present positions to rush madly off to shipyards which may not be able to accommodate them for the moment, but who stand ready, when called upon, to do a particular job for a particular wage in a particular place, and who have enrolled themselves in this organization so that when needed they may be readily reached.

The Need Is Great

The need of the nation is great. The Shipping Board has the money, the housing of men is being arranged for, the yards are being completed and the materials provided. All that now is lacking is the knowledge of the need that will inspire loyal and efficient mechanics to enroll for service in the yards, not in a fashion to disrupt the business of the country through the robbing of present industries. On the other hand, it is planned to make a careful selection of men whose places can be filled without hardship, and who when called upon to give up the jobs they now hold will have waiting for them definite positions at definite wages in definite yards.

Enroll at Once

It is urged, therefore, that mechanics go at once to the nearest enrollment agent of the United States Public Service Reresrve of the Labor Department, or to the local enrollment agent of his State Council of Defense, and register themselves as willing to work in the shipyards if needed; then to retain their present positions until called personally for service.

Through the Council of National Defense an appeal has been made to governors, mayors and other prominent officials, to stimulate interest in their communities.

Edward N. Hurley, chairman of the United States Shipping Board and president of the Emergency Fleet Corporation, says:

Inspiring Words From Chairman Hurley

"If the American people could be made to realize the necessity of building ships before this war can be won, they would subordinate local needs to national necessity. They would realize that, not merely the safety of the nation depends upon the quick building of ships, but that industry itself must be disturbed and labor inconvenienced until such time as all the shipyards are working to their maximum capacity.

"The man who lays down on the job in a shipyard, reducing his output, does not give employment to another man to make up his deficiency. Instead, he throws two or three men out of work, because everything that labor turns out for exportation must wait upon the completion of the ship which is designed to carry such supplies.

"To manufacture thousands of tons of war munitions and other commodities for our army and then send them to the seaports, and not have ships to carry these supplies to France, will cause more congestion at our seaport terminals and will ultimately result in the complete closing down of many of our industries.

"The happiness of every man, woman and child in this country is involved in the shipbuilding programme. Every rivet driven in the shipyards brings us nearer to the successful termination of the war. It is a question of manpower in shipbuilding, and within sixty days we will require 250,000 skilled mechanics to help the other loyal men now in the yards to build ships so fast that supplies can be furnished to our boys in the trenches who are making the supreme sacrifice for their country."

Charles Piez, vice-president and general manager of the Emergency Fleet Corporation, says:

"We have the task of getting the men, and we have the greater task of imbuing the entire community, the entire nation, with the supreme importance of this shipbuilding programme. It does take precedence over every other single effort that we are making to win the war, and that message must be carried to every citizen.

A Duty of the Highest Patriotism

"We must have inspiration in every man who works in the shipyards, and everyone connected with them. We must have the idea that a man who does work in the shipyard is carrying with him the same sacrificial service, performing the same duty as the man at the front.

"It is not merely a job of eight hours, paying big wages. Conditions are not ideal in every community where ships are being built, although the Government is trying to make them so. The men must have that impressed upon them—they must not kick; they must not resist going. They have temporarily to bear that burden so that these ships may be gotten out, and the cause won in the earliest possible time."

In addition to the card which the volunteer fills out for the Public Service Reserve, he signs the following franked postcard, addressed to Chairman Hurley at Washington:

"Appreciating the nation's imperative need for skilled workmen to build merchant ships with which to overcome the submarine menace, I request to be enrolled as a member of the United States Shipyard Volunteers of the Public Service Reserve. I realize that the world war will be won or lost in the American shipyards. Every rivet driven is a blow at the Kaiser. Every ship turned out brings America nearer to victory.

"It is understood that if I am asked to enter shipyard employment, my compensation shall be at the rate of wage prevailing in such yards."

The button which the workmen receive after enrolling bears this inscription: "U. S. Shipyard Volunteers."

A Service Certificate to All Who Enroll

The text of the certificate which is given to him upon enrollment, or sent later, reads:

"This is to certify (name of volunteer), of (city, state), has enrolled in the United States Shipyard Volunteers of the Public Service Reserve to aid the nation in its imperative needs for merchant ships with which to overcome the submarine menace and maintain our forces at the front.

"The world war will be won or lost in the American Shipyards. Every rivet driven is a blow at the Kaiser. Every ship turned out brings America nearer to victory.

"Those who give their strength and their influence to the speedy construction of ships render service that is patriotic and highly essential to the successful termination of the war.

"Edward N. Hurley,
"Chairman, U. S. Shipping Board."

The list below shows the kind of trades most needed in shipbuilding, and a particular appeal is addressed to men in those occupations to enroll in the Reserve:

Acetylene and electrical welders; asbestos workers; blacksmiths, anglesmiths, drop-forge men, flange turners, furnace men; boiler makers, riveters, reamers; carpenters, ship carpenters, dock builders; chippers and calkers; electrical workers, electricians, wiremen, crane operators; foundry workers; laborers, all kinds; loftsmen, template makers, machinists and machine hands, all sorts, helpers; painters, plumbers and pipefitters; sheet-metal workers and coppersmiths; shipfitters; structural iron workers, riveters, erectors, bolters up; other trades, cementers, crane men.

Training Shipyard Workers at Staten Island

Shipbuilders' School Started by State and City Departments of Education—Courses Offered—How Instruction is Given

BY R. V. RICKCORD*

THE eyes of the nation are concentrated on the production of ships. The giving up of the men for fighting purposes and the realization that ships are the only form of material connection between the American army and their base at home have made the nation expect that the ships will be quickly evolved and put into service. There has been published a welter of matter purposing to give forth what should be done to meet the situation; most of this is designed for the purpose of leaving the job to the other fellow. Presumably the output of opinion is but natural, since in a great many details the country is still going through the period of vision which always precedes the actual putting of ideas into action.

The establishment of a shipbuilding school at Staten Island is the outcome of concerted efforts on the part of the University of the State of New York (State Education Department) and the city of New York Department of Education to "get something started" and then to give the benefit of their experience to shipbuilders in other parts of the State and other sections of the country.

Shipbuilders Co-Operating

Of course, the enthusiastic co-operation of the shipbuilders of the neighborhood was largely responsible for the establishment of the shipbuilding school and the degree of success it has enjoyed up to the present time. No effort was spared by them to help the State and City Education Departments. And let it be here stated as a fundamental principle connected with the establishment of a shipbuilding school by city or State authorities that unless the actual and full co-operation of the shipbuilders themselves is enlisted at the very outset and is maintained all the time the school is in operation the chances of the school's success are very small.

The general requirements for the speeding up of ship production are, first, efficient management; that is, technical expertness combined with the skillful handling of men and material. Secondly, material; this in some cases has not been easily obtainable by the shipbuilders, but is now more or less being satisfactorily distributed. Thirdly, labor.

Labor Question of Utmost Importance

It need hardly be said that of the three, the question of labor is occupying the most serious attention of the shipbuilders; the labor problem is threefold, consisting of, 1, the housing of labor; 2, the acquisition of labor; 3, the education of labor to fulfill the shipbuilders' requirements. Again, the last of these problems is twofold and embraces the training of "green" men to enter the shipyard trades and the training of men already in the yards. It is the purpose of this article to deal with the training of labor and to make known the aims and the difficulties connected with the Shipbuilding School at Staten Island. Instruction in this school is limited to and given only to those who are actual shipyard workers, and consists of auxiliary supplementary trade information which ordinarily would be given by a foreman to an apprentice or which a journeyman tradesman would have to acquire from a book or from some other source. There is, however, a possibility that an attempt will be made to train "green" men also. Those who are receiving instruction and who may receive instruction in the near future can, therefore, be divided into the following categories:

a. Fully trained tradesmen who desire more knowledge of their trade.

b. Apprentices and helpers who require immediately the information and instruction which, with the skill they acquire in the shops, will make them good tradesmen and enable them to handle more easily the next job higher up.

c. Men who are not working at and have not worked at any of the shipbuilding trades, who in consequence need full practical instruction in the shops and the supplementary information given in the schools.

Numerous applications from all over the country have come from men who desire to join classes in shipbuilding. The idea of most of these men seems to be to first take instruction at the school and then to obtain a position in the yards on the strength of the instruction so obtained. Men of this type, however, have not been encouraged by those responsible for this work, since they do not in general desire to work in the yards without training, and the school is giving only such training as will supplement the actual practical training acquired in the shops.

How Instruction Is Given

The material of instruction is presented in a short, snappy manner and is arranged so that it can be covered in twenty two-hour lessons. As the lessons are given twice a week, each course will be covered in about ten weeks. At the end of that time a crowd of fresh students will be given the course, and the students of any one course may take another. In some cases the courses are consecutive and graduation from one is a requirement for entrance into another. For example: riveting, elementary shipfitting, advanced shipfitting, elementary mold loft work, advanced mold loft work and (perhaps) hull design, follow each other in the order given.

The so-called lessons are in reality a series of conferences; the instructor is merely a leader, and the students are given the greatest possible latitude consistent with a systematic form of teaching, to bring up and discuss questions and difficulties that have arisen during the day. The association of systematic teaching with the opportunity to bring up and discuss questions that arise during the day may seem a little inconsistent; this, however, is more apparent than real.

Sample Course

It may be interesting to analyze a sample course to show what is being done with each subject. The course is not only divided up into certain exact steps, but dates are set on which the steps should be given. There are two reasons for this exactitude. The first is that the instructors are tradesmen, and no matter how much they may know about their job, they need to have every facility placed at their disposal to make up for lack of actual teaching experience. The second is that the courses are

* New York State Department of Education and Technical Advisor, Staten Island Shipbuilding School.

short and snappy and the tendency would be to leave out certain portions unless it were completely determined beforehand what should be given during a period of instruction and how it should be given.

The marine plumbers' and pipefitters' course, for instance, is divided up as follows:

Lesson No. 1.—Study of different styles of water-closets used on ships and methods of installation.

Lesson No. 2.—Study of various kinds of valves used on ships and conditions under which their use is allowable.

Lesson No. 3.—Methods of installing lead pipe work for water-closets, bath tubs and other apparatus on ships.

Lesson No. 4.—Study of bilge and ballast piping systems and methods of installing.

Lesson No. 5.—Study of sheet lead work for purposes of refrigeration.

Lesson No. 6.—Blueprint reading in connection with ship's plumbing and pipe work.

Lesson No. 7.—Study of sanitary systems, arrangements for pumping, methods of installing pipe work, valves.

Lesson No. 8.—Study of fresh-water systems, arrangements for pumping, methods of installing pipe work, valves.

Lesson No. 9.—Methods of bending pipes; lead, iron and brass.

Lesson No. 10.—Methods of wiping joints; preparation fluxes, solders.

Lesson No. 11.—Study of heating systems, methods of installing pipework, valves, study of arrangements of various circuits.

Lesson No. 12.—Methods of doing watertight work on bulkheads and decks.

Lesson No. 13.—Expanded flanges, methods of making; advantages over ordinary flange work.

Lesson No. 14.—Kinds of flanges, making of joints, study of bolts and bolt spacing.

Lesson No. 15.—Studies in estimating quantities, measuring out and assembling material from drawings and on job.

Lesson No. 16.—Method of making and installing of main steam and exhaust pipes.

Lesson No. 17.—Hand pumps used on ships, study of their uses and methods of connecting.

Lesson No. 18.—Study of hot-water systems used on ships, methods of installing.

Lesson No. 19.—Scuppers, methods of making and installing.

Lesson No. 20.—Study of oil fuel piping systems. Making of special joints, methods of installing.

Lesson No. 21.—Study of standard flanges, pipes, threads, bolts, studs and other fittings.

Lesson No. 22.—Study of Lloyd's, Veritas and American Bureau requirements.

Instructors

The matter of obtaining instructors for the courses is an exceedingly difficult problem. When the hull superintendent and the foremen of mold loft, shipfitting and riveting departments have been pressed into service there is generally little more talent that can be used for what may be called the exclusively shipyard trades. The three trades just mentioned have proved to be, both from the standpoint of the shipbuilders' requirements and also from the number of applications for instruction, the most important trades dealt with in the yards. Experience in connection with the Staten Island Shipbuilding School would indicate that shipfitting instruction has been most in demand, and after that mold loft work and riveting. The following courses are now being given and set down in their order of importance:

Shipfitting.
Mold loft work.
Riveting, chipping and calking.
Shipwright work.
Ship coppersmith.
Marine plumber and pipefitter.
Wooden shipbuilders.
Ship sheet metal workers.
Marine boiler maker.
Ship blacksmith.
Ship electrician.
Outside machinist.
Inside machinist.
Ship drafting.
Sketch making for shipyard tradesmen.
Blueprint reading for shipyard tradesmen.
General ship construction.
General ship information for clerical workers and others.

The question has been brought up from time to time as to whether it would not be advantageous to take up the training of "green" men in the schools. The chief disadvantage is that this is a much larger problem to tackle; a full complement of working tools is necessary and it is impossible to reproduce in a small compass conditions as they exist in the yard. The apprentice or helper has already had a good insight into the mechanics of shipyard work. The most logical place for the giving of practical work to beginners is in the shipyard preferably on the vessel, but if necessary a shed in some corner of the yard can be used to great advantage for the purpose. Instruction can be given by a man told off especially for the purpose of training men; that is, by a man whose job it is to produce tradesmen and not to produce ships.

Newport News Training School

The training school of the Emergency Fleet Corporation at Newport News is for the purpose of producing men who are to give this practical instruction in the yards. The School gives the prospective instructors a training which cannot quite be replaced under any other circumstances at present. The instruction given in the shipbuilding school at Staten Island is auxiliary and supplementary to the instruction given by the men turned out in the Training School at Newport News. The opinion of the writer is that, in the case of the yards who have appointed a man or men to do the work of instructing without the Newport News training, the study of teaching processes and the systematic laying out of the steps in teaching are usually notably absent.

Though the complaint is often made by the shipyard managers that the men cannot be spared from the yard to take up the six weeks' course at Newport, yet as a matter of investment it is scarcely possible to imagine one more profitable in connection with shipyard work. This will be seen if a specific instance is examined. Take the case of a riveter who goes to Newport News for training. When the man returns he can probably handle five gangs of riveters. Of course, in order to do this he must not actually start his five gangs at one time, but preferably he should start one gang and stick to that until it is going sufficiently well to be left alone; the process is repeated in a few days on a second gang. This goes on until he has five gangs going, which is as much as one man can handle and instruct efficiently. At the end of three weeks the riveter is more or less fully fledged and can be trusted alone. It will be seen that nine weeks elapse from the

time the shipyard send a man to Newport News and the time the first batch of five riveters is turned out. At the end of eleven weeks from the time the prospective instructor started the yard will have sacrificed in productive power eleven man-weeks; but by that time five gangs will have been at work for two weeks and will have done labor in the yard to the extent of ten man-weeks. After three months the gain to the shipyard is out of all proportion to the sacrifice it has been called upon to make in sending the man to Newport News.

Of course, the yards must have at their disposal material ready to be trained as outlined above. The Shipbuilding School at Staten Island has now in the neighborhood of twenty-two instructors. It will be no exaggeration to say that there has never before been so complete a collection of technical and practical shipbuilding knowledge at the disposal of shipbuilding students under one roof. This is due to the efforts of the Staten Island shipbuilders themselves; Messrs. Armstrong & Quinn, of the Downey Shipbuilding Corporation; Messrs. Godoy & Scott, of the Standard Shipbuilding Corporation; Mr. James H. Davidson, of the Staten Island Shipbuilding Company, all of whom were unsparing in their efforts to start this school with as efficient a teaching force as the Island could possibly provide.

As far as possible, the instructor takes the men from his own yards. Where there are two instructors from one yard the rule is again made to apply, and he handles his own men from that yard. The result is a very close contact between the school and the yard, an assurance of regular attendance and the giving of instruction which definitely relates to work in the yard. A difficulty occurring during the day is discussed during the evening and corrected the next day under the supervision of the instructor.

Selection of Tradesmen as Instructors

In starting a shipbuilding school, there is always a great misgiving as to how the various tradesmen will turn out as instructors. The instructors in the Staten Island Shipbuilding School have not felt any difficulty yet in giving courses as laid out by the investigators and in deeply interesting the students. This was due mostly to the efforts and careful arrangements made by Mr. Morris Siegel, who is the assistant director of evening trade schools for the city of New York Board of Education. Fortunately, Mr. Siegel had a great experience in making successful instructors from tradesmen who had never taught before. To carry out his plan it was necessary to spend a great deal of time in the yards going over the various shop processes, picking out the information that could be given in the school and placing it down on paper. The instructor is given the prospective course divided up into from fifteen to twenty-five lessons, depending on the subject. He is required to take the subject matter for each lesson and write out the actual information he intends to give for the lesson. He is also called upon to propound a sufficiently large number of questions on the lessons, to insure that he will not become spun out. Questions brought up by the students are answered by the students themselves as far as possible. Rivalry and discussions among the students are encouraged. Long-drawn-out talks on the part of the instructor are avoided whenever possible.

If the number of shipyard workers within reach of a prospective shipbuilding school is large enough, say in the neighborhood of 5,000, a man should be engaged and paid either by the yard or by the authorities who establish the shipbuilding school. His work should be to keep in touch with the instructors and students in the yard, to find and engage patriotic speakers and lecturers on suitable technical subjects, preferably to be given at school assemblies, to keep the neighborhood and yards alive to the possibilities of such a shipbuilding school, and to do all those things which necessarily need to be taken care of in connection with a new and highly technical undertaking. If the school is a comparatively small one, a suitable man from one of the yards can be appointed to give part of his time to the project; but the part-time scheme is a dangerous one and should be watched very closely.

Method of Obtaining Students

The methods of obtaining students and the means of keeping them alive to the necessity of trade education were as follows:

a. Personal request from their foreman and superintendents to attend classes in shipbuilding.

b. Patriotic talks in the yard.

c. Posters distributed over the locality and hand bills distributed throughout the yards.

d. Enrollment blanks distributed among the shipyard workers through the department heads.

e. Small slips announcing courses placed in the pay envelopes of the employees.

f. Write-ups freely published in the local newspapers.

g. Good social organization within the school itself.

The shipyard men themselves report that after the establishment of the Shipbuilding School a distinct improvement and speeding up in the yard work of the students was almost immediately noticeable, and the peculiar shipyard clannishness seemed to be somewhat on the wane.

In view of the actual benefit felt and expressed by the shipbuilders, the large attendance of the students and the willingness of the superintendents of departments and foremen to give their time for the purpose of giving instruction, the school may be said to have so far accomplished its aims. No doubt the expenses connected with the organization and running of the Shipbuilding School are somewhat heavy, but these are not higher in Staten Island than they are usually found to be in the establishment of a trade school in the city of New York. The authorities of both the city and State of New York consider themselves well repaid for their efforts in attempting to help the shipbuilders to speed up production in this time of national emergency.

Board of Trade Issues Rules for Concrete Ships.—Preliminary instructions regarding ferro-concrete ships have recently been issued to shipbuilders and ship owners by the marine department of the Board of Trade. According to these instructions, ferro-concrete vessels will be required to comply with the requirements of the merchant shipping acts. All vessels which proceed to sea, except sailing vessels and non-propelled barges under 80 tons register solely employed in the coasting trade, must be marked with a load line as required by section 438 of the Merchant Shipping acts of 1894 and section 7 of the Merchant Shipping act of 1906. The decision of the load line is regulated by the requirements of the tables of freeboard (1909) and depends upon the strength of the hull. In order that the authority to whom application will be made for assigning of a load line may be fully informed of the structural arrangements upon which the strength of the hull of the ferro-concrete ship depends, full information as to the intended arrangements must be supplied by the builder to that authority and the vessel must be built under the inspection of the authority's surveyors.

Building the Hog Island Shipyard*

Gigantic Task Undertaken by Skilled Engineering Organization—Cost of the Work—Initial Difficulties

BY GEORGE J. BALDWIN†

ABOUT the middle of last May, General Goethals took up the programme then laid down by him of utilizing existing shipyards to the utmost for the building of steel cargo vessels, and in addition constructing new yards in which 3,000,000 deadweight tons could be manufactured in eighteen months, and called upon the American International Corporation for co-operation. About a month later the President signed the Urgent Deficiency Act, which supplied the means of financing the proposed construction, and we then submitted to General Goethals a tentative plan for his acceptance, which by July was so thoroughly worked out that we were ready to begin work. Owing to conditions familiar to all it was not until September 13 that the Emergency Fleet Corporation was able to finally instruct us to proceed. This unfortunate delay is the primary cause of many of the difficulties and is the definite reason for the large cost of the work.

All of those familiar with construction tasks realize the impossibility of obtaining in a time of universal disorganization of every industry both great speed and that standard of costs attainable in normal times. We must elect between them. Our instructions urged upon us the utmost speed, which cannot be secured without great cost. We were told that speed, not cost, was the essence of the contract; that we must build ships to save the nation, and not save money to fatten our pocketbooks.

Magnitude of the Task

Let us look for a moment at the task ahead of us on September 13, 1917. The American International Shipbuilding Corporation, a subsidiary of the American International Corporation, formed for the purpose with the approval of the Shipping Board, had undertaken to construct for Emergency Fleet Corporation fifty 11½-knot, 7,500-ton cargo vessels, each 400 feet long, and upon October 23 was awarded a second contract to build seventy 15-knot, 8,000-ton combined transport and freight vessels, each 450 feet long; also it was to build a shipyard suitable for the construction of not less than two hundred vessels in which the building of ships might continue as long as necessary on a scale and at a speed never before attempted.

We had already considered the designs for the 7,500-ton vessel prepared by Mr. Thomas E. Ferris, naval architect of the Shipping Board, but all of the detailed work ordinarily requiring months was ahead of us. No design had yet been worked out for the new 8,000-ton type. We had provisionally arranged methods of securing all of our materials, machinery and supplies. We had secured an option upon the best and apparently only adequate site on the Atlantic Coast for a shipyard of this magnitude adjacent to one of the large industrial cities, but beyond this little more could be done until the order was given to go ahead.

General Goethals' original plan was the construction of a yard with 50 shipways, upon which 200 vessels all exactly alike should be constructed. The task has been immensely complicated by the necessity of working upon its construction during the most severe winter known for many years, instead of during the fine weather of the autumn, as we had originally planned. After starting work upon the yard, the task was still further complicated and increased in magnitude by the addition of a second type of vessel of 8,000 tons, thus requiring the doubling of many facilities.

Size of Hog Island Plant

The Hog Island yard contains about 900 acres, and will have 50 shipways in five groups of 10 each, a fitting-out basin containing 7 piers each 1,000 feet long, with a capacity of four ships per pier. There is not in Philadelphia to-day a single pier of this length, and not many in the country. The classification, storage, holding yards and distributing tracks for material entering into the construction of the 120 ships require 75 miles of standard-gage railway track. The covered buildings, such as plate and angle shops, blacksmith shops, machine shops, etc., with office buildings, mess halls, fire stations, police headquarters, living quarters, etc., will include more than 25 acres under roof; 75,000,000 feet of lumber will be used, about half a million tons of steel and nearly 30,000 men will be required as a maximum—a larger force than has ever been organized for shipbuilding in any previous yard.

It is impossible to estimate the cost of such a proposition conducted under its many inherent difficulties, but we believe that the original estimate submitted last June of approximately $20,000,000 (£4,100,000) for the yard, which was concurred in by the best judgment of the officers of the Emergency Fleet Corporation and the engineers of the American International Shipbuilding Corporation, would have been sufficient if the work could have been commenced at that time. Difficulties in transportation and labor which could not be foreseen and the all-important fact that postponement in starting the work made it necessary to perform the heavy part of it during most severe winter weather will very materially increase the cost of the work.

Estimated Cost

The total estimated cost of the first fifty 7,500-ton boats at $1,100,000 (£226,000) each is $55,000,000 (£11,300,000). The fee for constructing each boat is $55,000 (£11,300), with certain penalties which may reduce it to $41,000 (£8,400), one-half payable when each boat is one-half completed, and the remainder when it is accepted by the Government. The second lot of seventy 8,000-ton boats at an estimated cost of $1,650,000 (£338,000) each totals $115,500,000 (£23,660,000). The fee per boat is $82,500 (£16,900), perhaps reduced by penalties to $65,000 (£13,300). The aggregate estimate for the boats and yard is $200,500,000 (£41,000,000), a large part of which will be expended in Philadelphia for labor, equipment and supplies, in addition to a probable expenditure for necessary housing for laborers of perhaps $10,000,000 (£2,050,000), or $12,000,000 (£2,460,000). This represents the largest development, the greatest effort and the quickest expenditure of that amount of money ever experienced by Philadelphia.

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* Extracts from an address delivered before the Philadelphia Chamber of Commerce on February 7.

† Vice-President American International Corporation and chairman of Board of American International Shipbuilding Corporation.

We have estimated that we can deliver twenty-five of these boats in 13½ months from September 13, 1917; 25 more in 15 months; another 25 in 18½ months; a fourth 25 in 20 months, and the last 20 in 22 months from this contract date, which will require an average delivery of one ship every two days during the eight and a half months specified.

The total tonnage so far ordered is 935,000 deadweight tons, capable when constructed of earning at rates fixed and approved by the Shipping Board Chartering Committee for steamers of 6,000 tons or greater deadweight capacity aproximately $10 (2/1/8) per ton per month, or, more exactly, $307,186 (£63,000) per day, or $9,215,593 (£1,900,000) per month. You can therefore readily see the importance of saving time as a commercial proposition, as if we can expedite time of construction by one month we save over $9,000,000 (£1,850,000), for each month's operation of the fleet, which is only the commercial value of these vessels. What they are worth for purposes of winning the war is beyond computation.

FEES

For doing this work we are to receive a fixed fee of approximately $6,600,000 (£1,350,000), equivalent to 3.3 percent upon the total monies expended. From this compensation must be deducted excess profits tax, which will probably reduce the final net compensation one-half. The salaries of executive officers, a large staff of highly paid men, and certain other expenses must also be paid by the company from the fee which it will receive. While not figured on a percentage basis yet, if so calculated the net fee to the corporation will work out to something like 1½ percent, if indeed it eventually averages that much. There are no indirect profits of any kind.

Much of the work, due to its urgency and the need for speed, must be handled by sub-contracts, which have been given to the most experienced and reliable contractors having organizations and equipment immediately ready. All sub-contracts are on a cost-plus-fixed-fee basis, the fee being calculated at 5 percent of the estimated cost of the work done, with certain allowances for depreciation of the contractor's equipment. These contracts, as part of the yard work, bring no profit of any kind to the corporation.

All wages and salaries are fixed by the Government. Materials used are purchased either by the corporation, as agent of Emergency Fleet Corporation, or, as in the case of lumber, piling, crossties, etc., directly by the Government Corporation. Every order given is approved in advance as to price and other detail by Emergency Fleet Corporation's representatives.

We were instructed to build fifty shipways, together with all the necessary shops and appurtenances, so that not less than 200 vessels could be properly built in the yard. All of the plans have either been furnished or approved by the Emergency Fleet Corporation. The vessels are being constructed under its specifications, and it has full control over all orders and instructions issued by us concerning the purchase of material, the progress of the work, the employment of labor and the rates paid. It furnishes all of the money necessary excepting the cost of the real estate, which is owned by our corporation. Finally, if at any time the work is not being done to its entire satisfaction, it has the right to terminate the agreement immediately, and at the end of the contract to purchase the land at its purchase cost by our corporation.

NEW METHODS OF SHIPBUILDING NECESSARY

The problem was to produce the greatest number of first-class steel ships in the shortest time. They must be cargo ships of ample carrying capacity and satisfactory speed. They could not be built in any of the already overburdened existing yards. Entirely new methods of shipbuilding must be employed never before used, but none of these things must be experimental. The vessels must be the result in every particular of well-tried methods which our machine shops, factories and shipyards had experimented with and approved in long practice. In answer to this problem three entirely new ideas stood out:

1st. A design so radically simplified and standardized that every succeeding vessel would be an exact reproduction of the first, identical in every detail, thus eliminating every possible variation in size and shape of material.

2d. The plan required the mobilization throughout the entire country of the largest proportion possible of all resources germane to shipbuilding and the adaptation of these resources to the new purpose. This included first and foremost the bridge and structural steel industries, then the builders of engines and boilers, the forges and machine shops and factories capable of producing any pieces of equipment entering into a ship, from a propeller shaft to a sextant. This meant a mobilization of the men, the plants and the engineers of more than 1,000 high-class manufacturing organizations throughout the United States. New organizations could not be thrown together, nor new plants built, to do this work; nor could it all be brought to the shipyard, as the output must be secured from thoroughly organized shops of long experience.

3rd. The reproduction of vessels in large numbers, every one of exactly the same construction, permitted the use of the factory methods in which America is preeminent. The new shipyard was to become the assembling floor of a colossal ship factory, whose machinery was made up of all the inter-related wheels of American industry, whose employees were a large part of the entire body of American labor, and whose conveyor belts were the American railways.

This solution, both in method and in magnitude, was a new departure in shipbuilding. Standardization had been attained to a slight extent in England, but on nothing like the scale demanded by the present programme. It required the consolidated and co-ordinated effort of scores of the largest, strongest and most efficient corporations in the United States and could not be accomplished in any other way. Ten or fifteen years ago, before our industries had achieved their present prominence and size, the task would have been an impossibility. To-day we are performing it.

WHAT THE "FABRICATED" SHIP IS

The "fabricated" idea simply means that you have a "manufactured" ship instead of a "made-to-order" ship, just as we have "manufactured" automobiles instead of "made-to-order" ones.

All non-essentials have been suppressed. Curvature of plates, especially those requiring multiple bending, were as far as possible eliminated. Ordinary structural steel beams were substituted for special ship shapes. No camber of the decks, but flat, like those of a battleship; no shear, but a straight deck line from bow to stern, perpendicular sides and a flat bottom; a strictly rectangular midships section, only curving on the bilges; a design of boat carefully combining the best ship and bridge builders' practice with that of our most efficient manufacturers. Maximum cargo space was adjusted to maximum safety, utilizing a multiplicity of bulkheads, which have saved more than one torpedoed oil tanker from going to the bottom. This designing has been so accurately and carefully done that the model tested in the Government testing

tank shows a speed as great and requires as little power as the average vessel turned out in our best shipyard practice.

If fabricated shipbuilding is a success, and there is no reason to suppose that it will not be, the methods of building cargo ships may be revolutionized. This is an ambition which any community would be proud to realize. Achieved by a city already noted for its great industrial development, it will be something to marvel at, but this will not come without effort, sacrifice and earnest civic endeavor.

In the conventional shipyard each vessel is designed and the specifications prepared in accordance with the client's desires. The steel and iron required in the form of plates, shapes, angles, etc., and all other materials are delivered from the mills to the shipyard where the plates are shaped and punched, the frames bent, punched and beveled, the riveting done, the stern posts and connecting rods, etc., forged, the pumps, boilers and engines built; in fact, every component part of the vessel worked out to a special design, so that each boat stands unique as an individual piece of workmanship, made such by a trained force of skilled shipbuilders.

America had standardized the construction of machine tools, making them better and cheaper than any other nation. It had standardized its agricultural machinery and supplied Europe, South America, Asia and Africa. It is pre-eminent among nations in manufacturing standardized, simplified machinery in wholesale quantities, and in place of the "made-to-order" individual ship we have simply substituted the manufacture of ships in wholesale quantities, something which no private concern has hitherto dared to experiment with on account of the vast amount of money required and the difficulty of selling or utilizing the product. No other opportunity has ever arisen under which such construction could be undertaken before the present emergency forced it upon us.

Initial Difficulties

Everyone who has followed the work in the International Shipyard is fully conversant with the tremendous physical difficulties encountered in converting an unimproved tract of shore property into a shipyard with the utmost speed. The nearest approach by trolley or railroad was a mile and a half distant. There were no connecting freight nor passenger lines, no water and no source of power supply. By the middle of January facilities, not the best in the world, but still unusual as transportation development goes, were at hand, sufficient to carry 22,000 men into and out of the yard. Roadways of standard construction have been built into and through the island, housing facilities for many thousand men completed, administration, engineering and other necessary buildings completed by the acre, freight lines built into the yard and tracks laid sufficient to permit the unloading of 250 freight cars per diem; a water system has been installed and electric power introduced. The essential features of the shipyard, the 50 shipways along the water front, have reached an advanced stage of completion. All this has been done in the face of the greatest railroad congestion ever known and during the most severe winter ever experienced, in Philadelphia, a winter in which for more than five weeks the thermometer has hardly gone above the freezing point.

If anyone should turn to his neighbor and ask him whether or not in four months it is possible to create a satisfactory organization embracing 22,000 people, the answer unquestionably will be no. It would be absurd to say that our organization of an equal number created in that space of time is fully satisfactory. There are but few organizations of this size in the country, all of which have been the result of many years of growth and careful preparation in normal times of peace. Yet, in spite of all that, and in spite of the natural difficulties of the site itself, and in face of the severe winter, one of unparalleled railroad congestion, we are to-day up to our schedule and the yard has reached a point of completion beyond which no one could humanly expect a job of this kind to have advanced.

Success Confidently Predicted

Moreover, I am able to-day to say that, if we can from now on secure a steady flow of material to the yard and if we are permitted to continue with the full programme of 50 ways after completing the 32 which we are now pressing forward most quickly, we expect to deliver the ships contracted for at the time originally expected. Furthermore, as nearly as we can now estimate, despite the increase in expenses and despite the delay in time caused by circumstances uncontrollable by anybody, the increased final cost of the 120 ships to be built by us as agent for the Government will probably not exceed 10 percent of their total cost, even charging the entire cost of the yard solely to these vessels.

Who are the people to whom this great work has been confided? Is it within their power to accomplish it?

What the American International Corporation Has Accomplished

The American International Corporation has been formed for the purpose of promoting international trade in American bottoms constructed by American shipbuilders and carrying the freight of American merchants to all quarters of the world. It was equipped to undertake great engineering tasks in foreign countries and to finance them with American capital. In carrying out these purposes it had rescued from destruction the well-known Pacific Mail Steamship Company, now successfully operating the only regular line of importance carrying the American flag between this country and the Orient. It had become interested in other ocean transportation lines and had purchased one of the oldest and best equipped shipbuilding yards in the country, whose force of naval architects, engineers and efficient shipbuilders was second to none, the New York Shipbuilding Corporation of Camden, which, in addition to carrying on its own great undertakings, has supplied nearly 100 men for Government service. We were therefore fully equipped to apply the very best American shipbuilding intelligence and experience to the new task.

Closely allied with the American International Corporation was the engineering firm of Stone & Webster, of Boston (builders of the great Keokuk dam and many other important works), which came to the job fresh from a most economical and quick construction of one of the great military cantonments. Although it had already supplied more than 800 men for national service, it still had an equal number of competent engineers and construction men ready for the engineering and construction end of the work.

A full knowledge of these facts caused General Goethals to select our corporation for this work and induced Mr. Hurley and Admiral Capps to confirm his judgment. There seemed to be no better combination of effective, organized power ready at hand and no time to build up new organizations. Those which had been perfected during long years of effort must necessarily be the ones to use if quick results were desired.

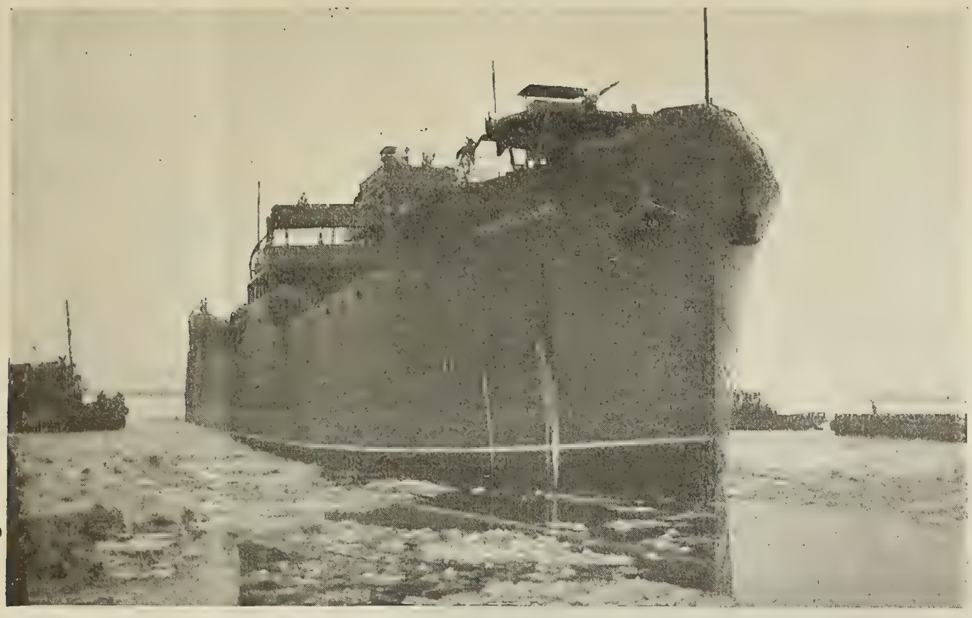


Fig. 1.—First Sun Oil Tanker Backing Out of Fitting Out Berth for Trial Trip.

Fig. 2.—S. S. *Chester Sun*, first 10,000-ton Oil Tanker Built by the Sun Shipbuilding Company.

Oil Tanker of 10,000 Tons Deadweight Adopted as Standard by Shipping Board

Description of Oil Tank Steamer Designed by Sun Shipbuilding Company and Adopted by Shipping Board as Standard

As a standard for the construction of oil tank steamships, the U. S. Shipping Board has adopted the plans and specifications of the 10,000-ton oil tanker designed by the Sun Shipbuilding Company, Chester, Pa. The Sun company has given the Shipping Board permission not only to adopt this vessel as a standard for future oil tank construction for the Government, but also to have vessels built in accordance with these designs at other shipyards without compensation to the Sun Shipbuilding Company.

The general design of the vessel was worked out by Mr. Albert Ed. Saunders, naval architect of the Sun Shipbuilding Company, while the design of the propelling machinery was in charge of Mr. A. A. Howitz, chief engineer of the Sun Shipbuilding Company.

The principal dimensions of the vessel are as follows:

Length overall	444 feet
Length between perpendiculars	430 feet
Beam, molded	59 feet
Depth, molded	33 feet 3 inches
Load draft, about	25 feet 6 inches
Total deadweight carrying capacity at above draft,	10,300 tons
Designed speed	10½ knots

General Arrangement

As can be seen from the general plans reproduced herewith, the vessel has a straight stem and semi-elliptical stern with the machinery aft. The hull is built on the Isherwood system of longitudinal framing and has two continuous steel decks from stem to stern, together with raised poop, bridge and forecastle decks of steel.

The hold is divided by transverse and centerline oil-tight bulkheads forming nine main cargo oil tanks on each side of the centerline. A cross bunker is forward of the machinery space aft and a water ballast tank is fitted forward.

A continuous expansion trunk extends between the upper and main decks from the forward boiler room bulkhead to the forward end of the main cargo tanks. Sum-

mer tanks are fitted in the wing 'tween decks, five on each side over the main cargo tanks.

Dry cargo space is provided in the forward hold and 'tween decks. The pump room for the cargo is amidships, while the bilge pumps are located in a steel inclosure in the forward hold. Reserve feed water and ballast are engineers' quarters, mess room, pantry, etc. The galley is on the poop deck abaft the engine hatch. The crew and petty officers, with their messrooms, etc., are located on the poop deck at the after end abreast of the engine hatch, while the cold storage equipment is on the main deck abaft the engine room.

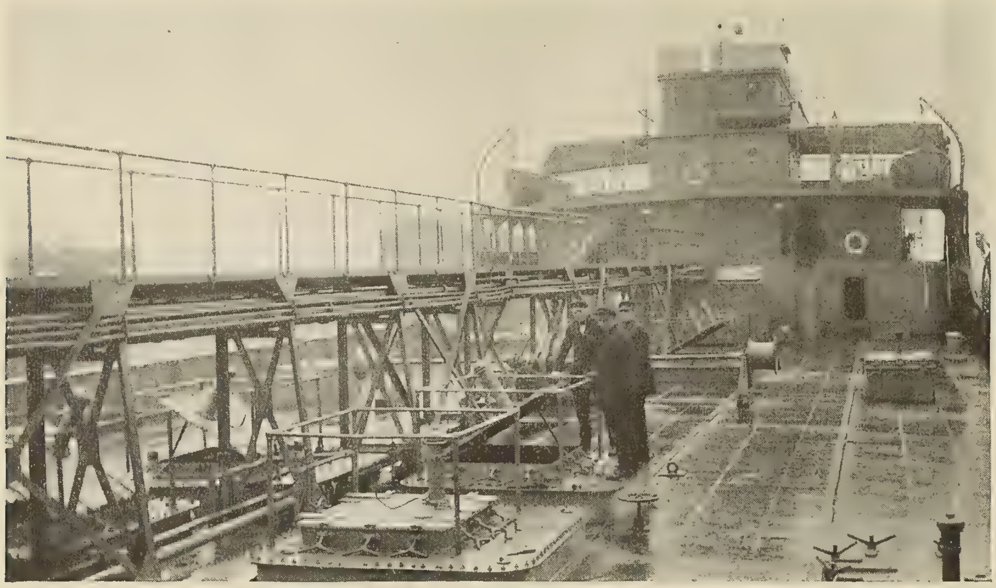


Fig. 3.—Upper Deck, Showing Runway and Hatches

carried in a double bottom extending only under the machinery space.

Accommodations

Houses under the forecastle are arranged for the boatswain's stores, carpenter shop, paint, lamp room, etc. The midship deckhouses are arranged for the accommodation of the captain, officers and saloon, with wooden chart and wheel house superposed. Steel houses aft on the poop deck abreast the engine casings are used for the

Oiltight hatches to each oiltight compartment are fitted on the upper deck, while cargo hatches are provided for the forward hold and to the cross bunker and poop 'tween decks.

The vessel is rigged with two hinged steel derrick masts and one wireless mast. Two 5-ton booms are provided on the foremast and two 5-ton booms on the mainmast. Hand and steam steering gear are provided in the aft 'tween decks, and a steam windlass forward on the forecastle deck. Deck winches with extended warping ends are

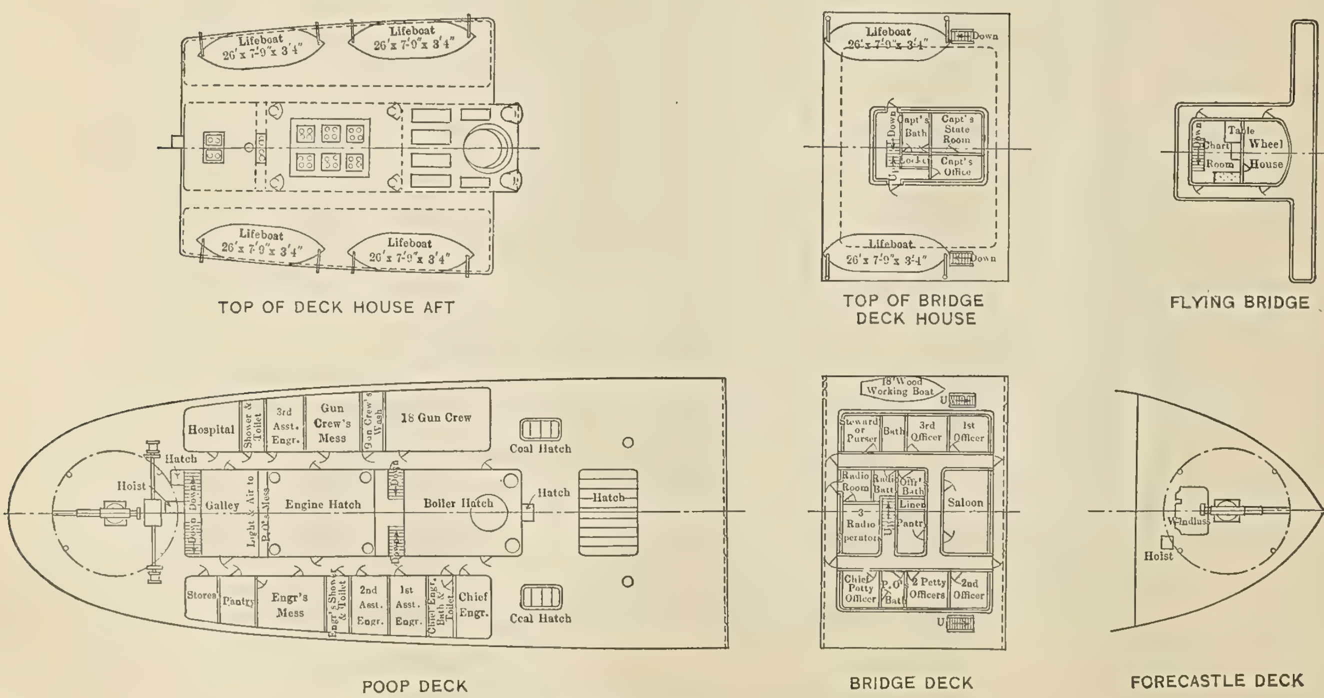


Fig. 4.—Plan of Poop, Bridge and Forecastle Decks

pplem

OIL TANKER OF 10,000 TONS DEADWEIGHT CARRYING CAPACITY

Designed by Sun Shipbuilding Company, Chester, Pa.

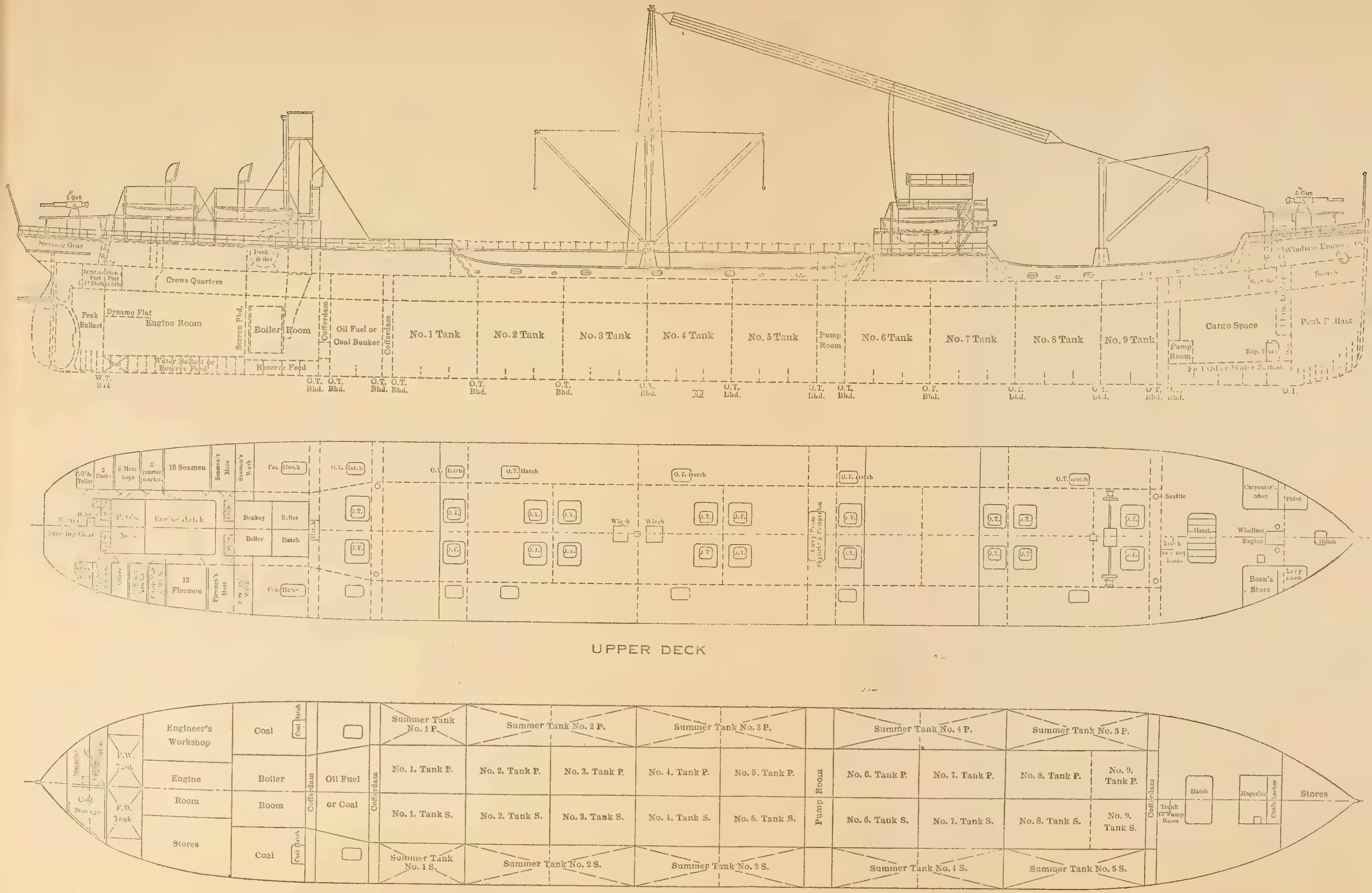


Fig. 5.—Profile and Deck Plans, Showing General Arrangement

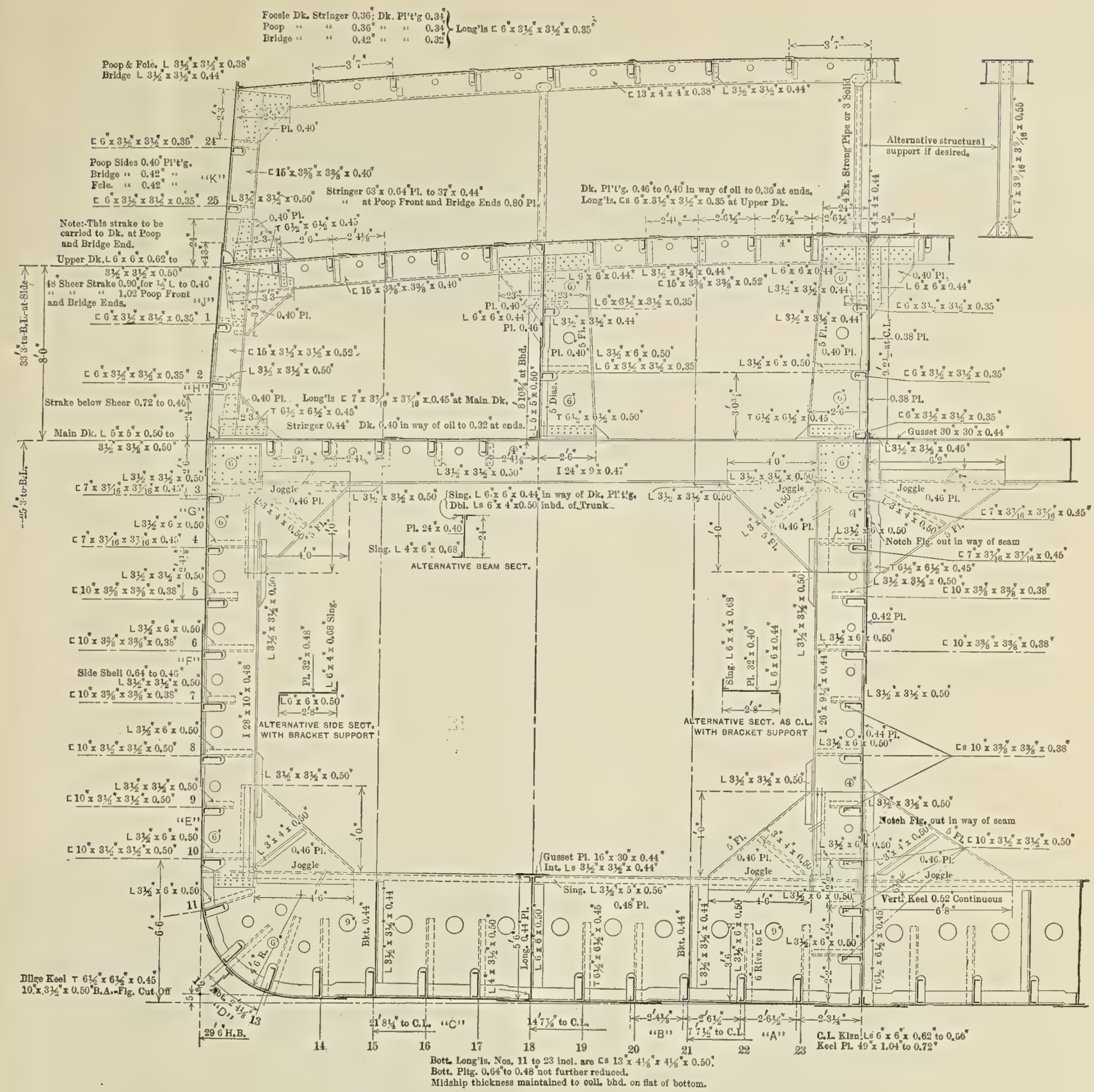


Fig. 6.—Midship Section, Showing Scantlings

located at the foremast and abaft the houses on the poop deck.

Hull Construction

The stem and stern frame are of cast steel. The rudder is of the single plate type with forged post, and is arranged so that it can be shipped or unshipped afloat.

The centerline vertical keel is fitted continuous in the inner bottom aft, connected to the flat plate keel and center strake of the inner bottom by angles. In the boiler room and cross bunker forward of the boiler room it is watertight. Through the holds the vertical keel forms the lower strake of the centerline oiltight bulkhead and is continuous the full length.

The centerline bulkhead is fitted throughout the cargo tanks, pump room, cross bunker and forward ballast tank. The bulkhead is plated in a fore-and-aft direction and cut at the transverse bulkheads. The bulkhead is stiffened by longitudinal stiffeners and by deep vertical webs at each transverse frame of the vessel. Arch openings are provided in the bulkhead in the pump room and cross bunker.

The transverse oiltight bulkheads are located as shown on the general plans dividing the hold into eighteen main cargo oil tanks, ten summer oil tanks, the pump room and cofferdams. These bulkheads are plated and stiffened horizontally and cut at the centerline bulkhead. Vertical web stiffeners are also fitted.

Watertight bulkheads are fitted to the after peak, forepeak, forward end of the boiler room, the bridge ends and elsewhere, as indicated on the general plans.

The expansion trunk between the main and upper decks is formed of continuous longitudinal bulkheads on each side of the centerline extending the full length of the main cargo tanks and cross bunker. These bulkheads have horizontal stiffeners connecting to the transverse bulkhead

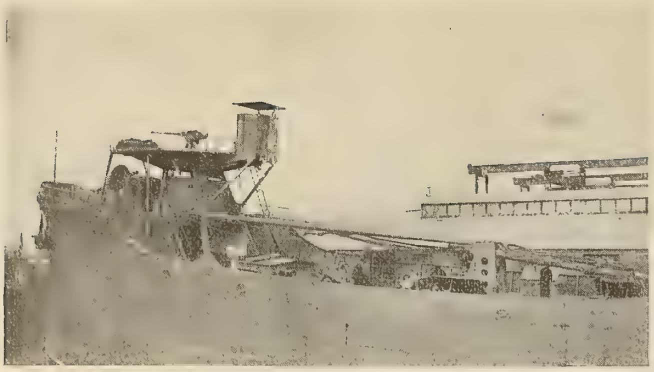


Fig. 7.—Bow of Vessel

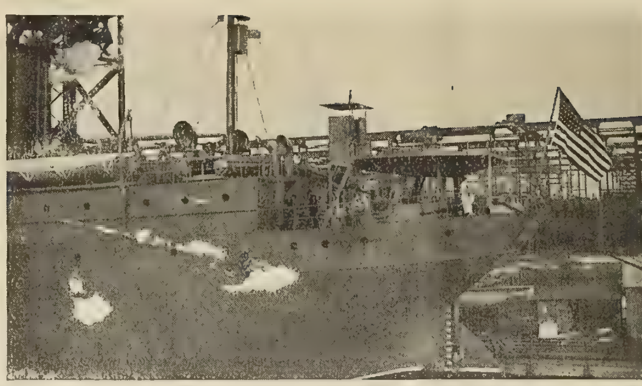


Fig. 8.—Stern

stiffeners by brackets. Transverse vertical webs are fitted at each main transverse of the vessel.

The shell longitudinals are of the size and arrangement shown on the midship section, Fig. 6. They are generally of channel section or built of plate and angles where the shaping becomes excessive. For the most part the longitudinals follow the shell plate edges.

Although the hull is built according to the Isherwood system of longitudinal framing, the forepeak is framed on the transverse system from the keel to the forecastle peak. Transverse frames are fitted abaft the peak bulkhead between the upper and forecastle decks and in the after peak between the keel and upper deck, and also in way of the thrust recess from the keel to the dynamo flat.

The decks are all plated fore and aft. Overhead in the poop deck, in way of quarters, a wooden ceiling is fitted between the beams in place of sheathing. Alongside the cargo oil hatchways the deck plating is increased and compensation is fitted where required.

The deck beams are of channels and fitted longitudinally between the peak bulkheads on the main and upper decks. On the main, upper and forecastle deck forward of the peak bulkhead and for the full extent of the forecastle deck and on the main and upper decks abaft the after peak bulkhead, transverse deck beams are fitted to every frame. The beams on the bridge and forecastle decks are also of channel section and run longitudinally. Hold stanchions are fitted in the freight space forward and in the bridge 'tween decks.

Two fresh water tanks, having a total capacity of about 10,000 gallons, are fitted in the 'tween decks abaft the engine room.

Ventilating System

Two 24-inch cowl ventilators are fitted to the dry cargo hold, with trunks in the 'tween decks decreased in diameter, leaving an annular opening at each deck for ventilating the compartment below. One 12-inch cowl ventilator is fitted for the forward pump room.

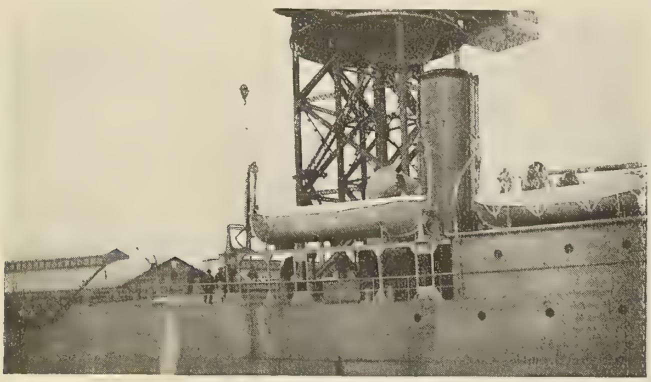


Fig. 9.—Forward End of Poop Deck

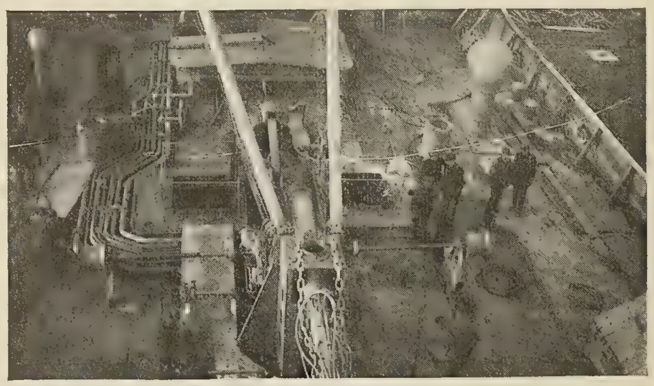


Fig. 10.—Mast Step

Fig. 11.—Runway on Upper Deck

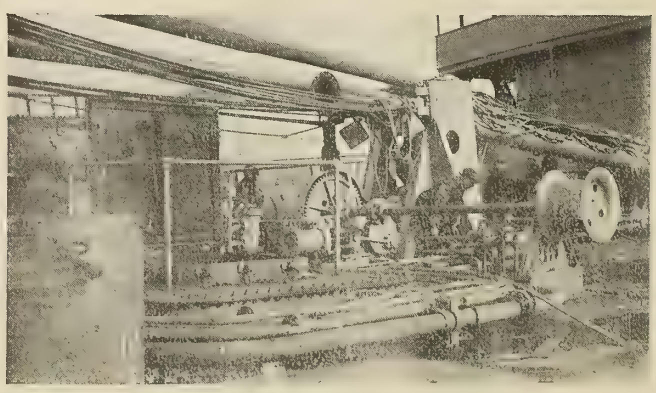


Fig. 12.—Hinged Mast

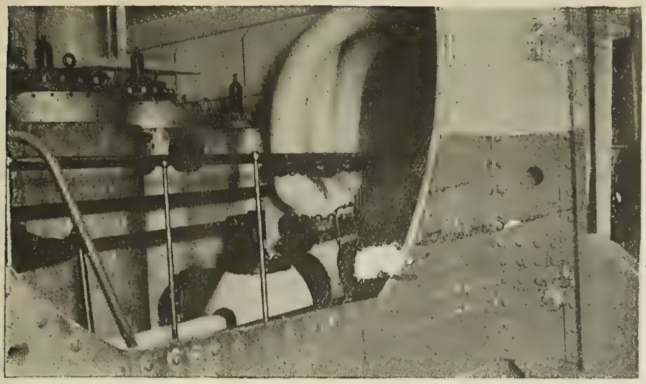


Fig. 13.—Upper Grating in Engine Room

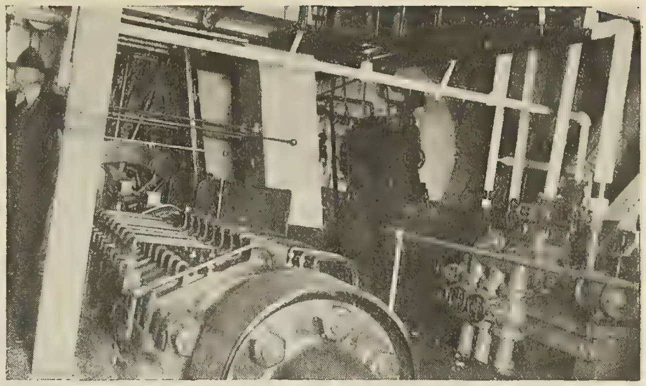


Fig. 14.—Thrust Block

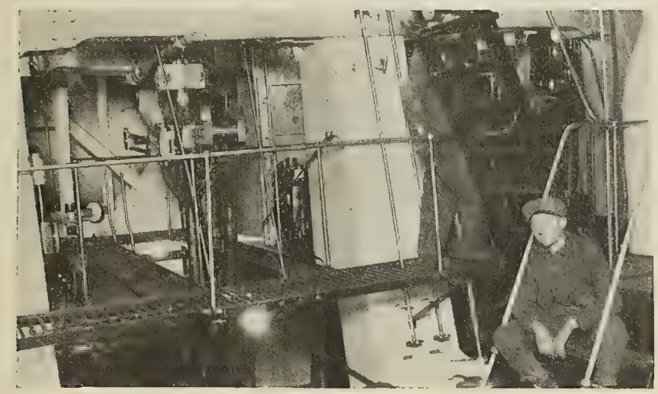


Fig. 15.—Lower Grating

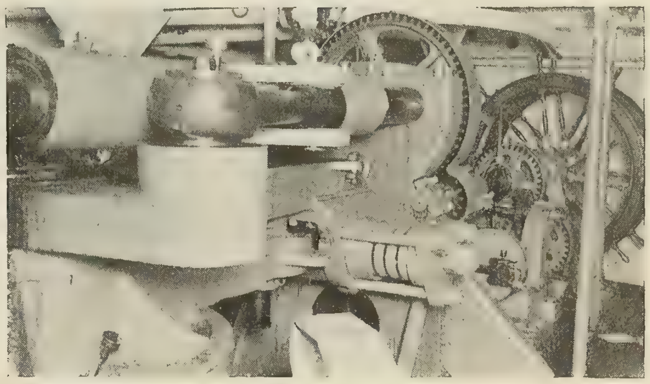


Fig. 16.—Steering Engine

The bunker space forward of the boiler room in the poop 'tween decks is ventilated by two 12-inch cowl ventilators. Two 12-inch cowl ventilators are also provided for the side bunkers and two more for the cross bunker. Two 18-inch ventilators are fitted to the steering gear compartments aft and 8-inch goose-neck ventilators are fitted to the storerooms below the upper deck.

Two 24-inch cowl ventilators are provided for the pump room amidships and the ventilation of the crew's quarters and machinery space is carefully worked out.

Propelling Machinery

Propulsion of the vessel is by a single screw driven either by a triple expansion reciprocating engine or by geared turbine machinery of about 2,700 shaft horsepower at 90 revolutions per minute. If a reciprocating engine is installed, it is of the triple expansion surface condensing type with cylidners 27 inches, 45½ inches and 76 inches diameter by 51 inches stroke.

The bedplate of the engine is of cast iron of box section. The cylinders are supported by six cast iron back and front housings of box section. To the back housing are attachments for the main air pump of the Edwards type and feed and bilge pumps.

The high and intermediate pressure cylinders are fitted with piston valves, while the low pressure cylinder is provided with a balance slide valve which is equipped with a balance cylinder with connections to the condenser. All of the valves are operated by the Stephenson link reversible valve gear.

The main condenser, which is independent of the main engine, has 5,000 square feet of cooling surface. For a reciprocating engine the condenser is designed to maintain a vacuum of 26½ inches with circulating water at 86 degrees F., while for a geared turbine arrangement the vacuum required is 28½ inches with water at 75 degrees F.

If turbine machinery is installed an independent air pump of the twin beam wet and dry type is provided, 14 inches by 32 inches by 21 inches. In this case the engine room bilge pump is a horizontal duplex pump 6 inches and 5¾ inches by 6 inches. The main feed pump for turbine drive is a vertical simplex, 12 inches and 8 inches by 18 inches.

Auxiliaries

The machinery equipment also includes the following pumps:

Auxiliary feed, vertical, single, long-stroke type, 12 inches by 8 inches by 18 inches.

Fire and bilge pump, horizontal duplex, 14 inches by 10 inches by 12 inches.

Water service and sanitary pump, horizontal duplex, 6 inches by 5¾ inches by 6 inches.

Fresh water pump, 5¼ inches by 4¾ inches by 5 inches.

Circulating pump, double suction centrifugal type, driven by single vertical engine.

Forward bilge pump, horizontal duplex type, 6 inches by 5¾ inches by 6 inches.

Bilge pump in pump room, 6 inches by 5¾ inches by 6 inches.

Salt water feed pump, 5¼ inches by 4¾ by 5 inches.

The auxiliaries also include an evaporator having a capacity of not less than 30 tons in twenty-four hours.

All accommodations are heated by steam taken from the auxiliary line in the engine room.

The vessel is lighted by electricity furnished by two 15-kilowatt marine direct-connected sets driven by vertical engines, located on the main deck in the engine space.

The refrigerating plant consists of a 2-ton ammonia ice machine installed on the main deck in the engine room

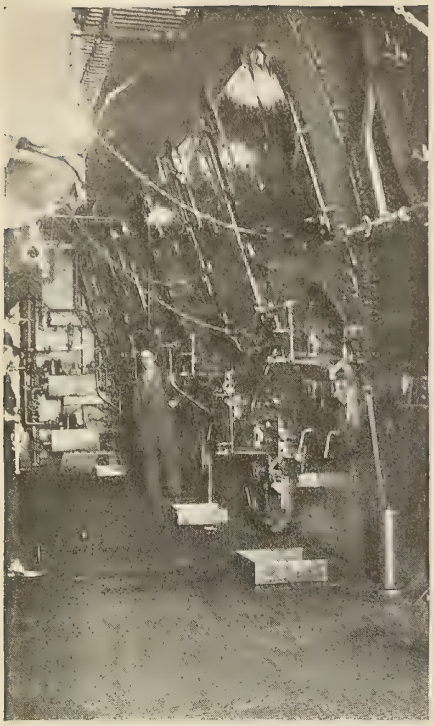


Fig. 17.—Fireroom

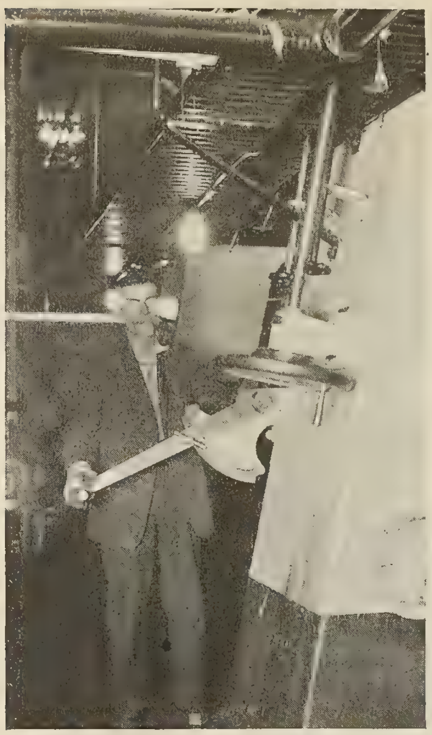


Fig. 18.—Operating Station

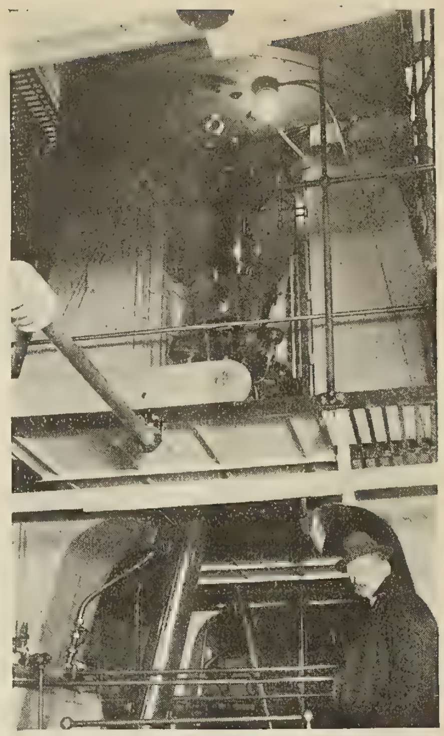


Fig. 19.—After End, Main Engine

and supplied with steam from the auxiliary line. The ice machine is connected to the cold storage room and is also fitted with ice-making pans of sufficient size to provide 200 pounds of ice daily.

Cargo Oil System

Two cargo oil pumps of the horizontal duplex type, each 16 inches by 14 inches by 18 inches, are fitted, one on each side of the pump room amidships with both suctions and discharges cross-connected, so that either pump may draw from the port or starboard main and discharge into the main on the opposite side. They may also draw from the forward mains and discharge into the after mains and vice versa. The discharge of each pump is fitted with a relief valve discharging back to the pump suction.

A 10-inch sea suction is fitted on each side of the pump room cross-connected in such a manner as to allow the tanks to be filled by gravity.

Each pump is fitted with a 10-inch delivery pipe carried up through the pump room to the athwartship discharge

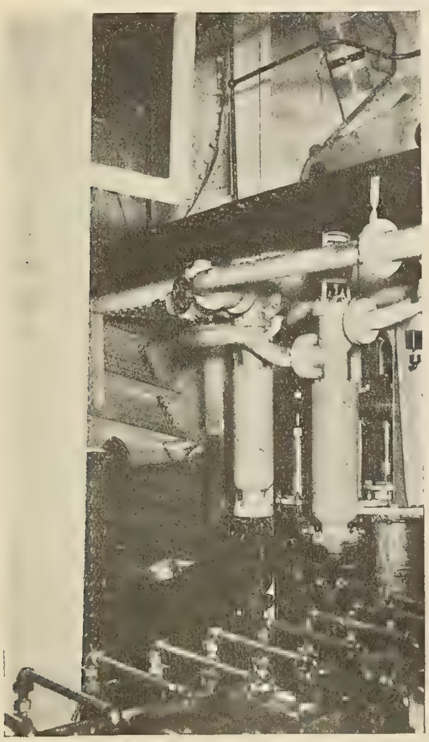


Fig. 20.—Attached Pumps

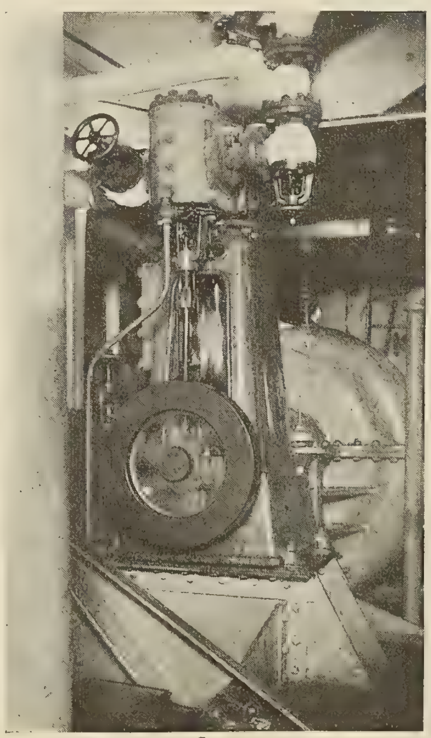


Fig. 21.—Circulating Pump

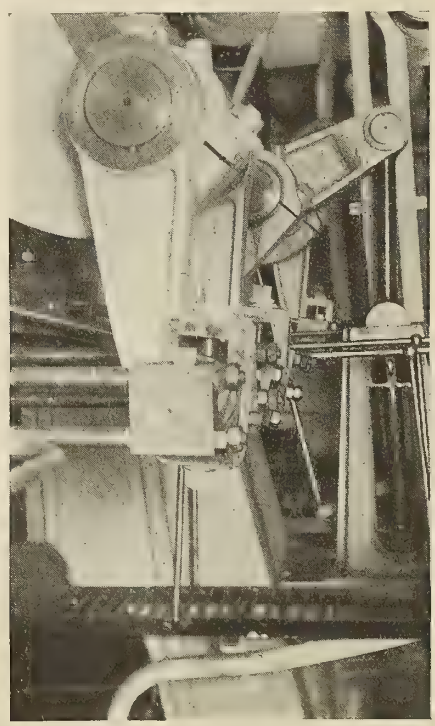


Fig. 22.—Reversing Gear

main. This delivery pipe is also connected to the pump suctions so that the athwartship mains may be used for either taking on board or discharging oil by the cargo pumps.

Two suction mains, 10 inches in diameter, run throughout the length of the ship, one on the port and the other on the starboard side, with 8-inch bell-mouth suctions in each tank, fitted with cut-out valves operated from the deck. The suction mains are cross-connected in the forward and after tanks with division valves operated from the deck.

All main lines are fitted with steam connections for blowing them out.

The summer tanks are fitted with deck valves at the lowest part of each tank for filling from and draining to adjacent main cargo tanks. The valves are operated from the deck.

Expansion in the main lines is provided for by the use of cast iron expansion joints with brass glands.

All cargo tanks are fitted with 5-inch vent pipes and relief valves. Each main cargo tank has heater coils fitted consisting of 1½-inch wrought iron pipe along the ship's longitudinals and around the bell-mouth suctions. Drain valves, operated on deck, are located in the summer cofferdams, draining into the main cofferdams.

Main Boilers

Steam is supplied at a working pressure of 190 pounds per square inch from three single-ended Scotch return tubular boilers, 15 feet 3 inches outside diameter and 11 feet 5 inches long between heads.

In place of Scotch boilers, watertube boilers of an approved design and type, with a working steam pressure of 200 pounds per square inch, may be used. In this case the heating surface is to be not less than 9,000 square feet. With turbine drive superheaters are fitted of a size sufficient to heat the steam 75 degrees F. above the temperature of the saturated steam.

The boilers are fitted for burning oil as fuel under a mechanical atomizing system, although they can be arranged for coal firing if desired. For oil burning a horizontal duplex pump, 7½ inches and 6 inches by 10 inches, is installed in the fireroom for pumping oil from storage tanks and discharging to a settling tank. The entire bottom of the storage and settling tanks is covered with heating coils of 2-inch pipe.

Two horizontal duplex pumps, 5¼ inches and 3½ inches by five inches, are fitted to draw from the settling tanks and discharge through strainers and oil heaters to the burners. Two fuel oil heaters and duplex suction and discharge strainers are provided in the oil lines, so arranged that either strainer can be cleaned without shutting down the pumps.

If Scotch boilers are installed, a forced draft system of the hot air type is provided, air pressure in the ash pit equal to a column of water 1 inch in height being maintained by a single blower installed in the engine room and driven by a vertical engine. If watertube boilers are installed, an induced draft system may be provided, consisting of a fan in the uptake driven by a single cylinder inclosed engine with automatic lubrication.

Trials

The specifications call for a dock trial of the vessel when completed, with the engines working full speed at full boiler power, with 1½ inches air pressure in the furnaces, and a six-hour sea trial with the ship loaded or ballasted to a mean draft of 25 feet. During this trial a speed of not less than 10½ nautical miles per hour must be maintained.

Working of Air Pumps Investigated by North-East Coast Institution

Investigations into the working of condenser air pumps recently begun by a committee of engineers appointed by the North-East Coast Institution of Engineers and Shipbuilders will include air pumps of the reciprocating type and of the rotary and jet types. A report has already been made which deals with tests made on pumps of the reciprocating type only. The point of chief technical interest is the fact that the tests have demonstrated that remarkable influence in the withdrawal of air from a condenser is possessed by a steam jet or a series of jets when used in combination with such pumps.

It is also of particular moment to note that, while the use of a steam jet has hitherto been associated mainly with the production of high vacuum such as is required for steam turbines, the report makes it clear that, for the production of low vacuum such as is standard for the reciprocating engines of cargo vessels, the jet system may be even more effective.

The original conception of combining a steam jet with an air pump was due to Mr. James Atkinson, of London, who in 1884 proposed it in connection with the cooling of liquids under high vacuum. In 1902 it was developed by Sir Charles Parsons for use with steam engine condensers, and at later dates has been considerably improved by Mr. D. B. Morison, of Hartlepool. These improvements, known as the kinetic system, are dealt with in the report, together with various other systems now in general use.

From the standpoint of economy, the effects of the adoption of the jet system are evidently extremely valuable. As is well known, a reciprocating air pump is a highly important auxiliary on a steamship. Its cost depends on its size; its wear and tear on its speed of working, and its economy in operation on the quantity of steam that it uses. The report shows that for a given duty the combination of a steam jet on the kinetic system will allow the speed of a given pump to be reduced from sixty strokes per minute to twenty and the consumption of steam to be reduced by one third, the pump mechanism remaining exactly as at present. Alternatively and obviously, the pump may be made smaller for a given duty, or, in the case of cargo vessels in which the air pump is driven by the main engines, the entire economic influence of the steam jet may be utilized in reducing the size of the main condenser and the pumps in connection therewith. Herein lies the present value of the report.

At no time in industrial history have savings in the use of labor and of metals been of such paramount importance as now. Apart altogether from the technical value of the results obtained, the investigations just completed indicate how such savings can be made in the manufacture of a particular part of the equipment of a steamship. The lead given by the North-East Coast Institution in the matter of active research, with the practical demonstration of how labor and material can be saved in manufacture, and, as in this case, higher efficiency obtained in operation, becomes, therefore, of national importance, and should at once be followed by every engineering institution.

The committee appointed by the Council of the North-East Coast Institution to carry out the tests outlined above consisted of Mr. Edwin Orde, of Messrs. Armstrong, Whitworth & Company, president of the North-East Coast Institution of Engineers and Shipbuilders; Dr. Morrow, M. Sc., of Armstrong College, the well-known authority on steam turbines; and Mr. Waldie Cairns, M. Sc., consulting engineer, of Newcastle-on-Tyne.

Eight Months of U-Boat Warfare

Evasion Proves Best Defense Against Submarines —Records Show German U-Boat Blockade a Failure

BY LEONARD M. PASSANO

ASIDE from the moral question as to the barbarity of submarine attacks as a method of warfare, upon which the civilized world is unanimous in condemnation, the submarine may be regarded from two points of view: First, as a means of warfare, and, second, as an instrument of warfare. It is particularly with the latter that the present article deals. It may be well, however, first to review the situation from the more general standpoint of the submarine as a means of warfare.

During the period from the week ending April 8 to the week ending December 9, 1917, the number of arrivals and departures of vessels from British ports was 188,012. In that period the number of vessels sunk by submarines was 826, or .44 percent. In a recent speech, Secretary Daniels asserted that "one thousand ships have been added to allied tonnage since entry of the United States into the war." The question of tonnage is as important as the question of the number of vessels. The incomplete evidence available indicates that the Allies have maintained the tonnage of their merchant fleets as well as the numbers. Undoubtedly, also, many enemy submarines have been captured or destroyed, so that even if Germany, at best, has been able to maintain the number of her U-boats, she is not accomplishing the destruction of Allied shipping. The submarine as a means of warfare must be pronounced a failure, though a danger and a menace.

In considering the submarine as an instrument of warfare three points must be dealt with. First, the ratio of the number of ships attacked to the number of arrivals and departures (sailings) at British ports; second, the ratio of ships sunk to sailings; third, the ratio of the number of ships which beat off attacks to the number of sailings. A fourth point, of perhaps secondary interest, is the ratio of ships sunk, and of ships which beat off attacks, to the number of ships attacked. Fig. 1 deals with the first three of these questions, Fig. 2 with the fourth. The amount of the tonnage attacked or destroyed is a secondary consideration from this point of view. The effectiveness of the submarine as an instrument is tested even more severely by a small ship than by a large one as far as finding the ship is concerned, and is tested in about the same degree by each in the sinking of the ship.

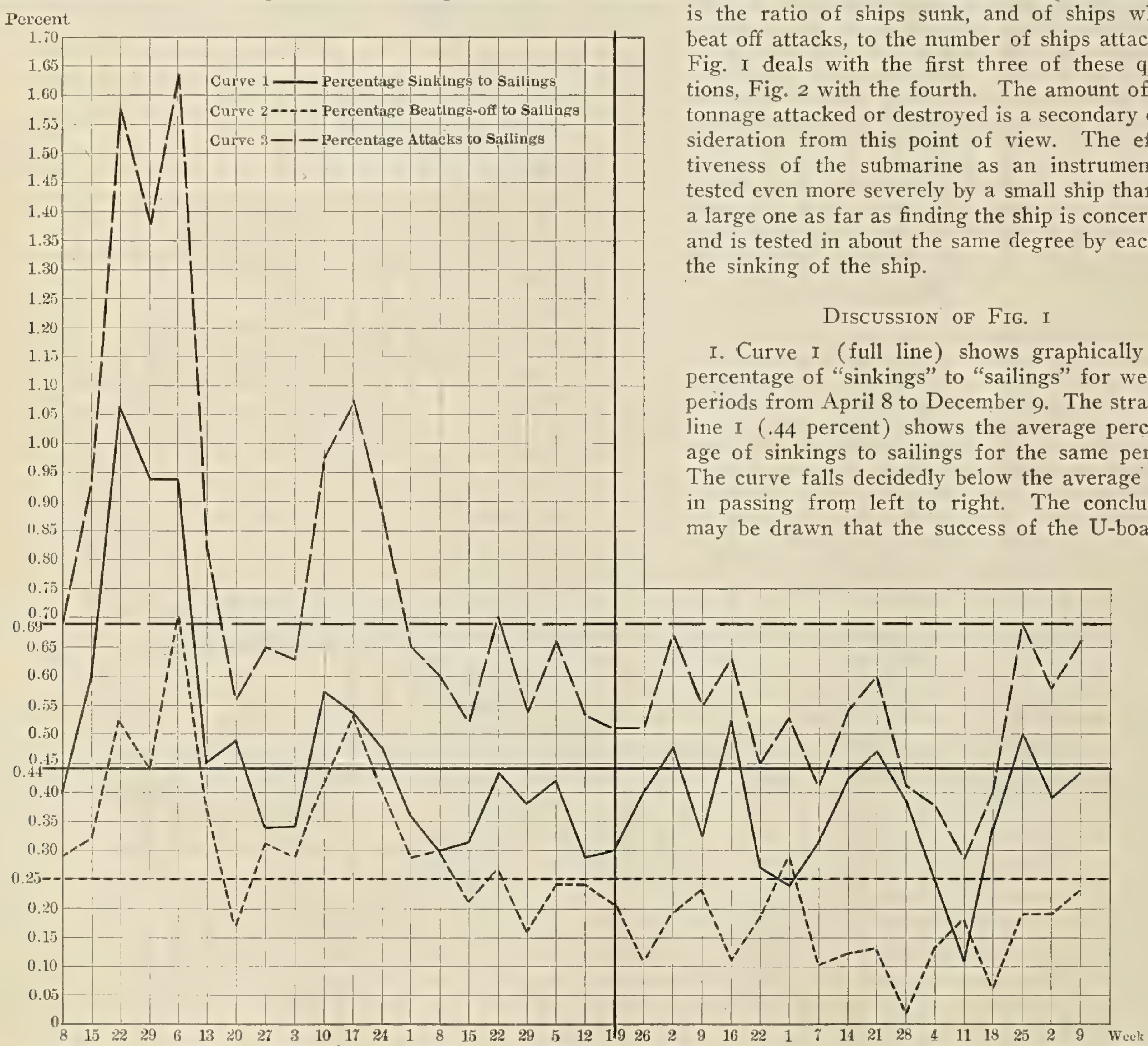


Fig. 1.

Discussion of Fig. 1

1. Curve 1 (full line) shows graphically the percentage of "sinkings" to "sailings" for weekly periods from April 8 to December 9. The straight line 1 (.44 percent) shows the average percentage of sinkings to sailings for the same period. The curve falls decidedly below the average line in passing from left to right. The conclusion may be drawn that the success of the U-boat in

destroying (in addition to finding or discovering) ships has decreased.

2. Curve 2 (dotted line) shows graphically the percentage of "beatings-off" to sailings for the same period. Straight line 2 (.25 percent) shows the average percentage of beatings-off to sailings. This curve also falls decidedly below the average line in passing from left to right, showing that the success of ships in escaping from, in addition to evading, the U-boat has decreased.

3. Since both the success of the U-boat in sinking ships and the success of ships in beating off attacks have decreased some common factor must be looked for as the cause. This common factor is probably the unfavorable weather conditions of fall and winter, which make it easier for ships to evade the submarine, but also make it easier for U-boats to do their work and escape when the victim is once discovered. Increased strength of convoys would suggest itself as another factor, since the convoy, by preventing the submarine's attack, would reduce both the percentage of beatings-off and of sinkings. As will be pointed out, however (paragraphs 7 and 8 following), there are reasons to believe that weather conditions are a factor of primary importance.

4. Curves 1 and 2, on being compared, show two markedly distinct periods. In the first period (April 8 to August 19) the curves rise and fall simultaneously, which indicates that good weather conditions (spring and summer) are equally favorable to U-boat and ship. In the second period (August 19 to December 9) the maxima, or highest points, of one curve correspond to the minima of the other. A possible explanation of this fact will be mentioned in paragraph 9 under the discussion of Fig. 2.

5. Curve 3 (dash line) shows graphically the percentage of attacks, successful and unsuccessful, to sailings for the same periods. The heights of curve 3 are, of course, the sum of the heights of curves 1 and 2. Straight line 3 (.69 percent) shows the average percentage of attacks; in other words, the average percentage of discovery of ships. That is, the submarine finds, on the average, 69 out of every 10,000 ships that enter or leave port.* Curve 3 falls very decidedly below the average line in passing from left to right, which indicates that the success of the U-boat in attack (i. e., in discovering ships) has decreased.

6. The principal cause of this decrease is, probably unfavorable weather conditions. (See paragraph 8.) On the other hand, the extreme height of curves 1 and 3 in the beginning is probably due to the sudden outburst of U-boat warfare after a long period of preparation. These extreme values make the average value of the percentages high and doubtless explain, in a measure, the failure of the U-boat to "come up to the average." The submarine is probably a more efficient instrument of war than curves 1 and 3 would indicate.

Doubtless, also, the destruction of U-boats faster, perhaps, than they can be built or replaced is another reason for the downward tendency of curves 1 and 3, while another factor of importance is that the number of sailings is less in the fall and winter months—the right hand half of the graphs. Fewer U-boats, fewer sailings, and bad weather would make the discovery of ships by the submarine more difficult. The following table shows the effect of the calendar on the number of arrivals and departures.

TABLE

APRIL 8 TO DECEMBER 9

Average Number of Sailings	Greatest Number, June 17	Difference	Smallest Number, Nov. 25	Difference
5,223	5,890	+ 667	4,180	— 1,043

APRIL 8 TO AUGUST 19

Average Number	Greatest Number, June 17	Difference	Smallest Number, April 15	Difference
5,438	5,890	+ 452	4,710	— 728

AUGUST 26 TO DECEMBER 9

Average Number	Greatest Number, Aug. 26	Difference	Smallest Number, Nov. 25	Difference
4,953	5,709	+ 756	4,180	— 773

It must be borne in mind also that another possible factor in the decrease of the percentage of ships discovered and attacked is failure of the U-boat to obtain information as to sailings. Doubtless many sources of secret information have been discovered and suppressed.

DISCUSSION OF FIG. 2

7. Curve 1, Fig. 2 (full line) shows graphically the

* For the period April 8 to August 19 the number is 83 in 10,000; for the period August 26 to December 9, 52 in 10,000.

percentage of sinkings to attacks; straight line 1 (64 percent) the average percentage of sinkings.

Curve 2 (dash line) shows the percentage of beatings-off to attacks; straight line 2 (36 percent) the average percentage of beatings-off.

These two are, of course, complementary curves. Where one rises the other sinks proportionally.

The rise of curve 1 and the fall of curve 2, with reference to the average lines in passage from left to right, show an increase in U-boat success in destroying (not in discovering) ships and a decrease in the success of ships in beating off (not in evading) the U-boat.

8. It can hardly be assumed that the U-boat has become more skillful in attack while the ship has become, relatively, less skillful in defense. Probably the skill of both has increased. On the other hand, there is no reason to believe that more ships are sailing unarmed for defense, and there is reason to believe that more are being convoyed. The conclusion may be drawn, therefore, that bad weather conditions (fall and winter) are favorable to the submarine in sinking, though not in finding, ships.

9. The rise of curve 1 would explain also the reversal of maxima and minima in curves 1 and 2 of Fig. 1 for the period August 19 to December 9. Given bad weather conditions, in any week that a U-boat finds ships, it is likely to succeed in sinking a large percentage of them before they can prepare to beat off the attack.

Summary

10. The submarine as an instrument of warfare cannot be called successful, chiefly because of its failure to discover or reach its victims; but it is reasonably effective and increasingly so, relatively, in conditions of bad weather, if it succeed in finding the ships to be attacked. Good weather appears to be about equally favorable to U-boat and ship, the advantage, if any, being with the submarine. Ships armed for defense have a reasonable chance of beating off attacks in good weather; less chance in bad weather. Convoyance would appear to be a secondary factor (paragraphs 3 and 8).

11. The conclusion to be drawn is that every possible means should be employed to make the discovery of ships difficult. The strictest precautions should be taken that no information reach the submarine as to date, place or route of sailing. It is particularly important now at the approach of the good weather of spring, when renewed U-boat activity must be looked for, to realize that the safety of ships from submarine destruction depends not only upon defense, but also, and primarily, upon evasion; and this is particularly so because, though ships and tonnage may be restored, the cargoes of ships that are sunk are irretrievably lost. Evasion is the best defense against the submarine, considered either as an instrument or as a means of warfare.

Diesel Piston Cracks

UNDER the direct influence of heat, cast iron cylinder components in internal combustion engines frequently crack and become utterly useless, in many cases after a short period of life. Piston heads have, undoubtedly, to stand very high temperatures during working. In an ordinary four-cycle gas engine at full load the center of the piston head may seem to be at a dull red glow, approximately 650 to 700 degrees C., and in the Diesel engine the temperature of the inner surface in the center of the piston head, directly in line with the fuel admission valve, is at least 900 to 950 degrees C. In many cases "star cracks" in Diesel engine piston heads can be traced to mechanical defects, such as bad designs or defective cooling arrangement, which under the influence of heat tend to set up unequal strain in the material, a state of affairs which under the conditions of working—the high temperatures and high alternating gas pressures—is extremely likely to bring about fracture.

The only change indicated by analysis of cast iron taken from various positions in cracked Diesel engine pistons is in the condition of the carbon content, the combined carbon being practically wholly converted into free or graphitic carbon. There appears to be no indication of the oxidation of the carbon or silicon contents. In experiments with gray cast iron bars which were heated in an open iron tube and quenched in water at the room temperature, the combined carbon was rapidly converted into the free carbon form at 750 degrees. Also it appeared that a temperature between 750 and 900 degrees had little influence on the rate of decomposition, nor did any influence appear to be exerted by the varying phosphorus content (0.016 to 0.85 percent). In samples of gray cast iron heated to between 900 and 950 degrees, analysis showed the reabsorption of a portion of the free carbon; one sample in which the reabsorption had probably reached its maximum for the temperature, was perfectly glass hard. This sample contained 1.13 percent of phosphorus.

While a microphotograph of a portion of a cracked Diesel engine piston, well away from the area affected by the heat, showed the normal structure of a low phosphorus gray cast iron, another of a portion directly affected by the heat exhibited an enormous increase in the dendritic structure, and the whole of the matrix appeared to be intersected by graphite plates. Near the extreme upper edge of the piston, directly in contact with the flame, the extent of the dendritic structure was much less, and the matrix appeared to be dotted with many more finely divided graphite plates. Also what seemed to be numerous small holes might be noticed. In photographs of the first set of gray cast iron bars mentioned, after heating for eighty hours (8 hours a day for ten days), numerous curly plates of free carbon were visible, and in the second set most pronounced swelling of the graphite plates was observed. This swelling, or rather the replacement of the graphite plates by holes, is in some way connected with the reabsorption of the free carbon. The swelling and thickening of the worm-like graphite forms may be seen in all the heat-treated samples, and it may be concluded that as a result of the internal changes, which take place only in a localized portion of the piston top, the iron is rendered considerably weaker, and the slight exterior changes will be responsible for a condition of internal strain.

Apart from mechanical defects, the ultimate cracking of Diesel engine piston tops can as a general rule be ascribed to the high phosphorus content of the iron. By reducing the phosphorus to the lowest possible limits it has been found possible to prolong the life of the pistons considerably and practically to eliminate the troublesome cracking. —*From a paper by J. E. Hurst before the Iron and Steel Institute.*

A clean fire and clean tubes make for good steaming.

It is astonishing how cool the engine and fire rooms are to the captain in the pilot house. It is a West Indian proverb which says, "The stone in the river bottom does not know how hot the sun is."

Fig. 1.—Italian Destroyer *Indomito*, a 680-Ton Vessel, Equipped with Tosi Turbines of 15,000 Horsepower. Speed on Trial, 35 Knots; Maximum Speed, 37 Knots

Tosi Marine Steam Turbines

Types of Turbines Built by Firm of Franco Tosi, Legnano, Italy, for Naval and Merchant Vessels

In view of the widespread adoption of steam turbines for the propulsion of both naval and merchant vessels, readers of Marine Engineering, will undoubtedly be interested in the developments which have been made by the firm of Franco Tosi, Legnano, Italy, the largest firm of steam turbine builders in Italy. For many years this firm has been engaged in the building of steam turbines, and have so far built turbines aggregating over 1,100,000 horsepower, in units varying from 12 horsepower up to 25,000 horsepower. Of these more than 800,000 horsepower have been for marine purposes. This firm to-day employs about 6,000 men in its shops.

The type of turbine adopted by this firm is shown in Fig. 2 and consists, as can be seen from the illustration, of one impulse wheel and one reaction drum, the latter constituting the intermediate pressure and low pressure stages of the turbine. If the turbine is built for a stationary plant it is built in one drum. If, on the other hand, the turbine is designed for naval work with reduction gears, it would be built in two drums, one for high pressure and the other for low pressure.

For low powered turbines, or for turbines with medium or high power, but which have a high speed, if the intermediate stage were built complete as a reaction tur-

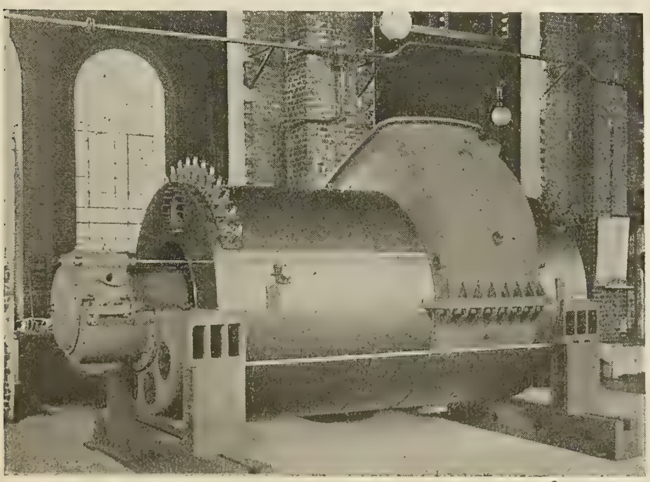


Fig. 2.—9,000-12,000 Horsepower Turbine, 750 Revolutions per Minute

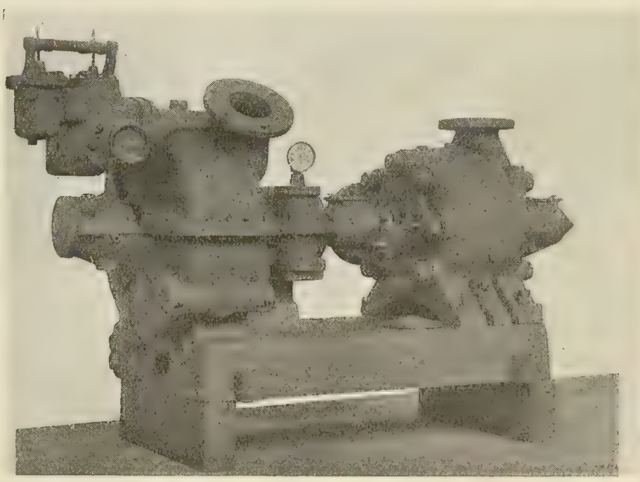


Fig. 3.—Turbo Boiler Feeding Pump

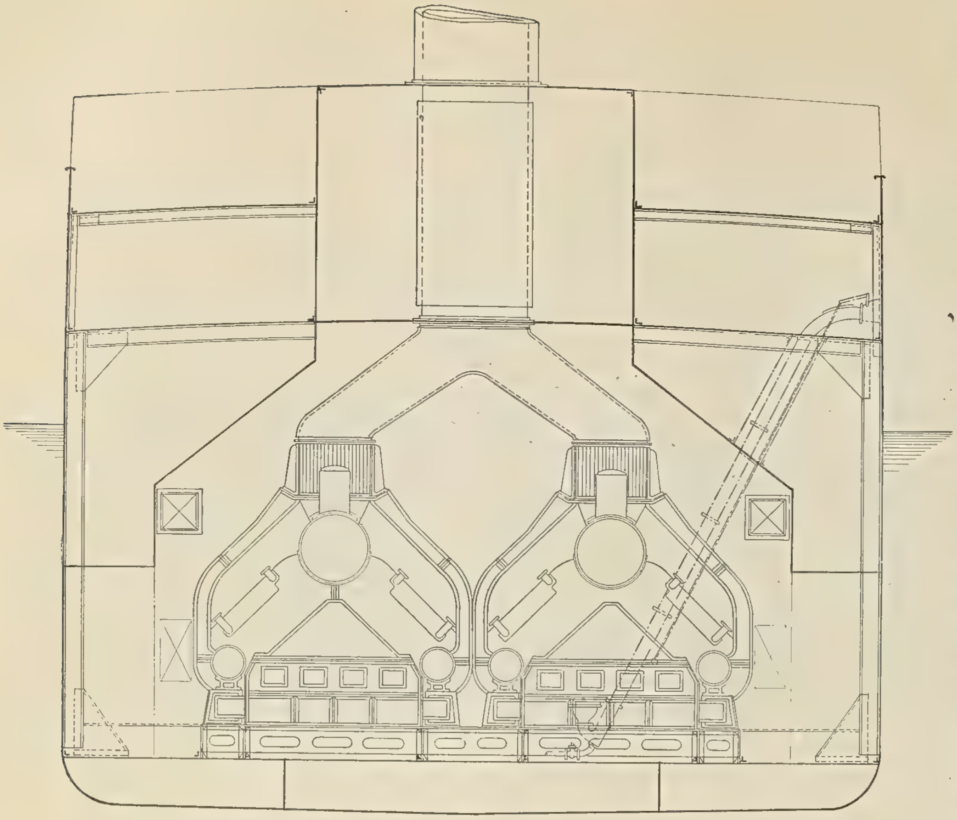


Fig. 4.—Section Through Boiler Room, 3,000 Horsepower Cargo Steamer

bine the resulting efficiency would be too low because the first rows of blades would be too small; therefore, instead of using only one drum, this firm makes use of the two impulse wheels and one reaction drum. In marine turbines for direct drive, that is, coupled direct with the propeller shaft and, therefore, designed to work at relatively lower speeds, it would be of little advantage to adopt only a one impulse wheel and one reaction drum for the intermediate and low pressure stages, because the blades of the reaction drum, especially in the first rows, would be too small for efficient operation and, in consequence, the efficiency would be poor. For this reason, the Tosi firm builds turbines in which the impulse parts are increased and reaction parts diminished. This method has the advantage that the thrust which the steam produces at the beginning of the low pressure stage of the turbine is directly equal to the propeller thrust.

Figs. 4-7 show the machinery arrangement for an installation of a 3,000 horsepower turbine for a cargo boat as built by the Tosi firm for different owners. Double reduction gears are provided which reduce the turbine speed from 2,700 revolutions per minute to 80 revolutions per minute. The gears are constructed in such a manner that they insure perfect working at any speed.

A characteristic part of the Tosi turbine, which is patented, is the strong construction of the blades, which will be noted from Fig. 11.

The stuffing boxes are protected by protection boxes in such a manner that if the stuffing boxes should come in contact with a stationary part of the turbine the danger of ruining the shaft is eliminated. This feature avoids the extensive repairs which would be caused by a ruined shaft, as all that would be necessary would be to renew the protection box. The labyrinth packing is of the carbon ring type with equilibrium rings to balance the proper weight.

In this case a 60 horsepower turbine drives the centrifugal circulating pumps, the oil pumps for the whole service and the condensed steam-extracting pump. The oil pump, which is of the rotary type, serves to supply oil to the main turbines, to the reduction gear and to the centrifugal boiler feed pumps.

The turbo boiler feed pump, driven by a two-wheel impulse turbine, is shown in Fig. 3. Turbo blowers serve to put the whole blower room under a pressure of one inch of water. They are of the high speed turbine type and run at about 6,000 revolutions per minute.

The condenser is located underneath the low pressure turbine, in such a manner that the flow of the exhaust steam is much more regular and the danger of water being retained in the turbine is eliminated.

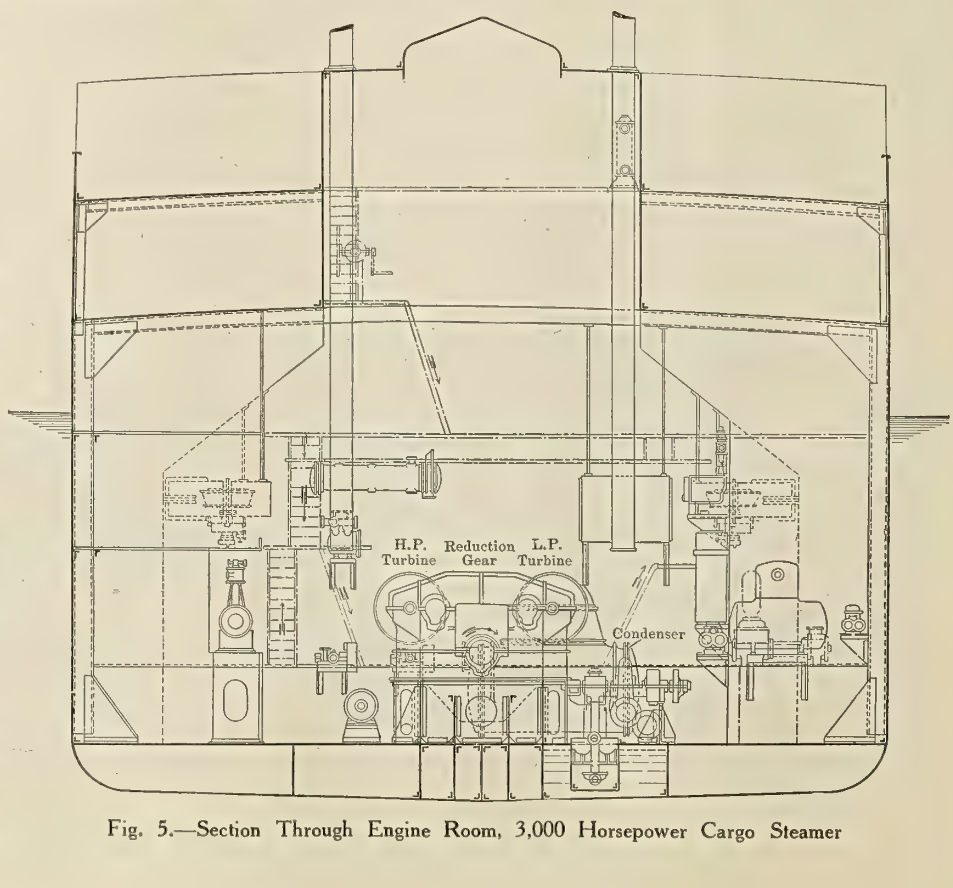


Fig. 5.—Section Through Engine Room, 3,000 Horsepower Cargo Steamer

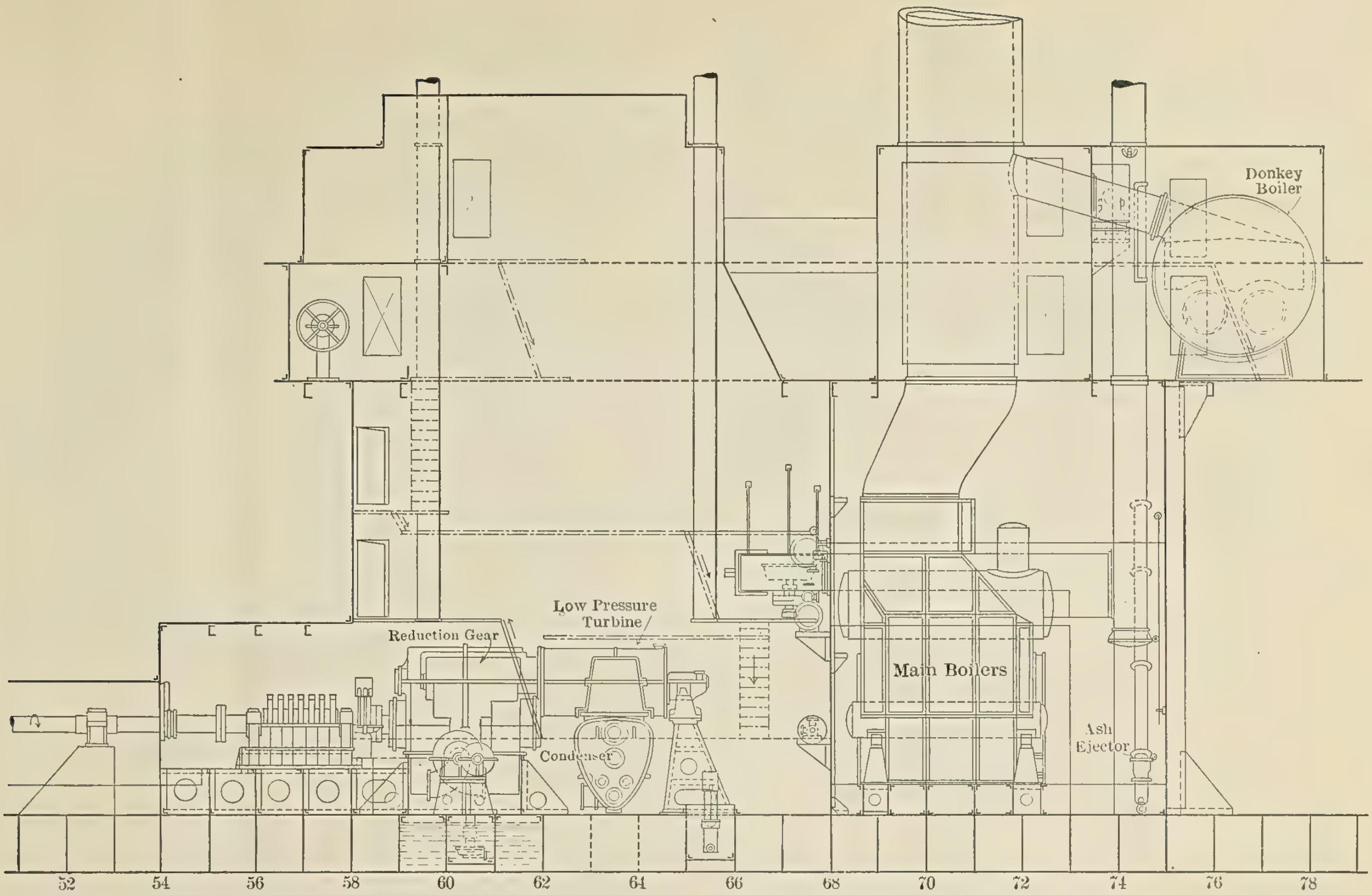


Fig. 6.—Longitudinal Section Through Machinery Space, 3,000 Horsepower Cargo Steamer

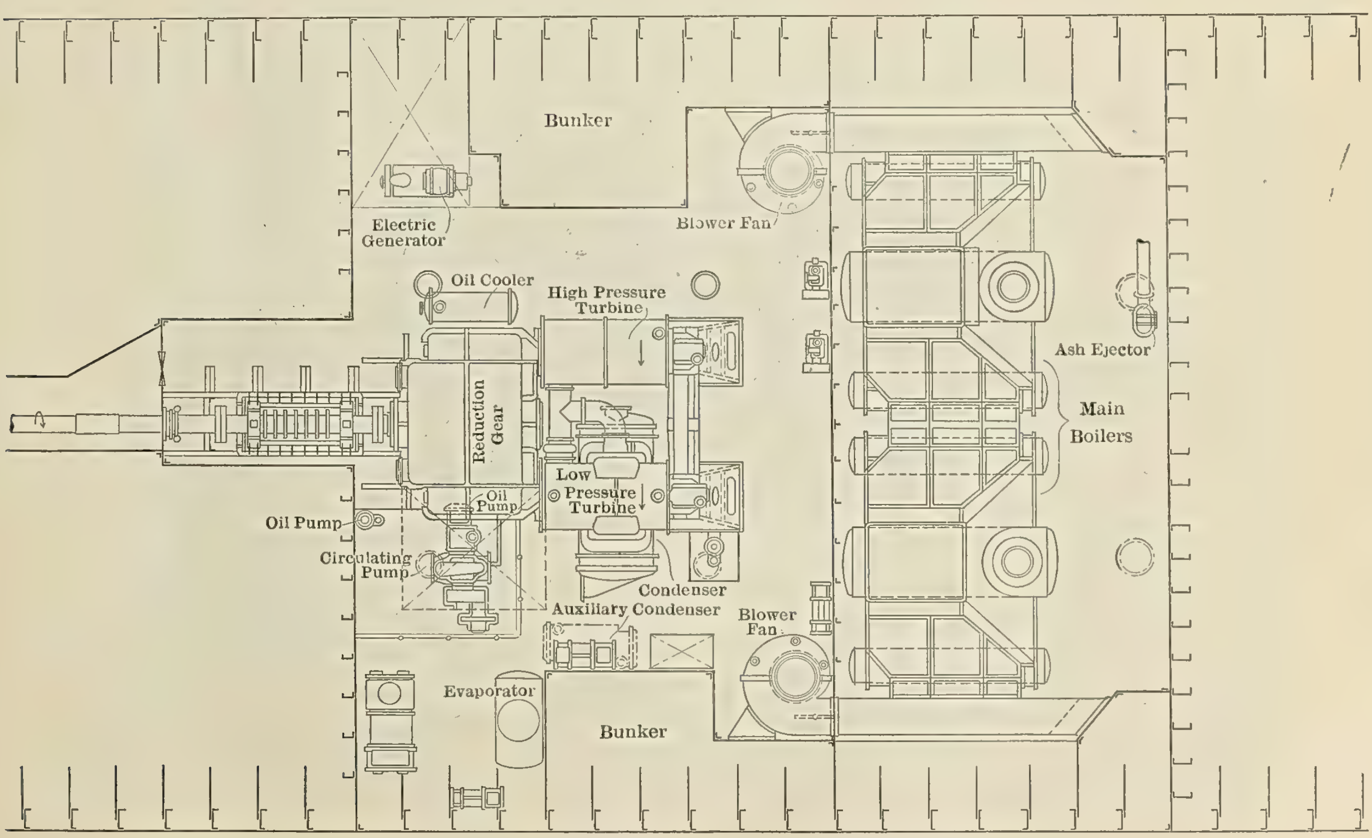


Fig. 7.—Plan of Machinery Space, 3,000 Horsepower Cargo Steamer

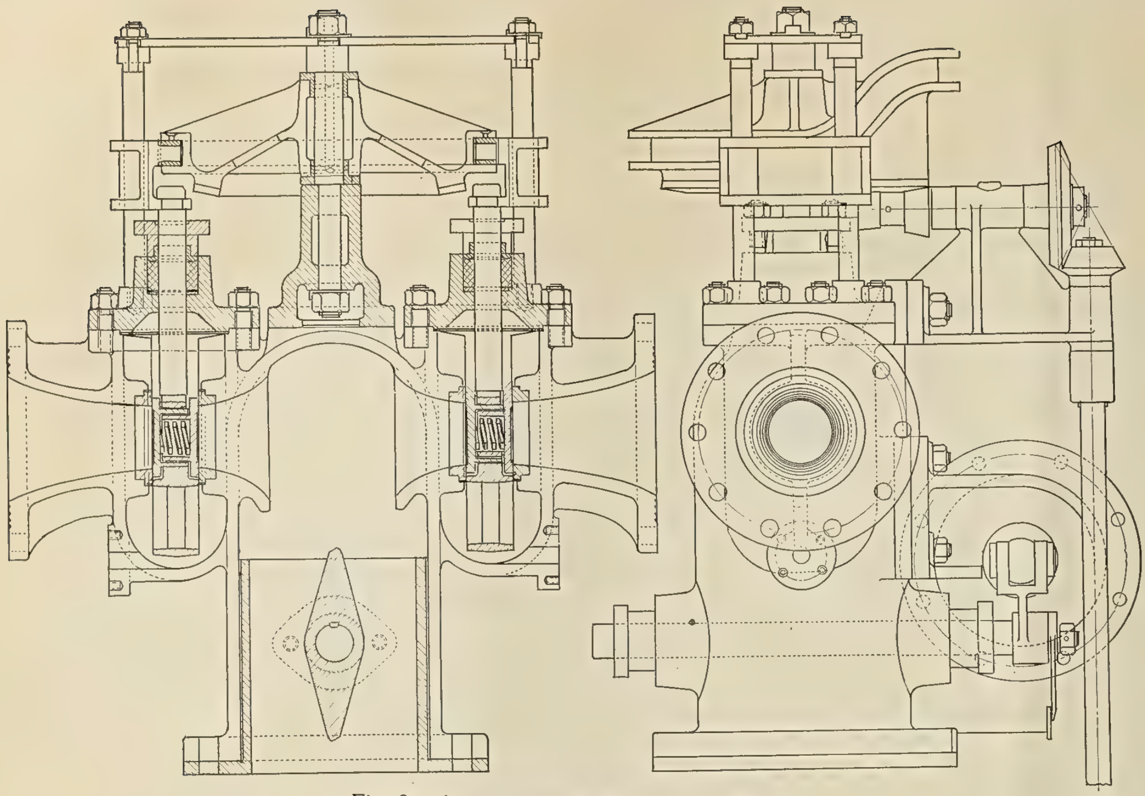


Fig. 8.—Arrangement of Maneuvering Valves

The arrangement of the maneuvering valves is interesting. These valves are of the double-face sluice gate type of very light construction, which are kept tight by steam pressure. The maneuvering is done by hand and is interlocked in such a manner that it is impossible to open the hand valves for the ahead turbine if the valve of the astern turbine is not closed or vice versa. A speed governor is placed at the end of each main turbine, which governs the speed of the turbine. If the speed of the propeller, due to the movement of the ship raising the propeller out of water should rise 20 percent above the normal speed, the governor would automatically let out oil through a small valve which is placed at the head of the turbine itself, so that the oil pressure would be decreased under a piston

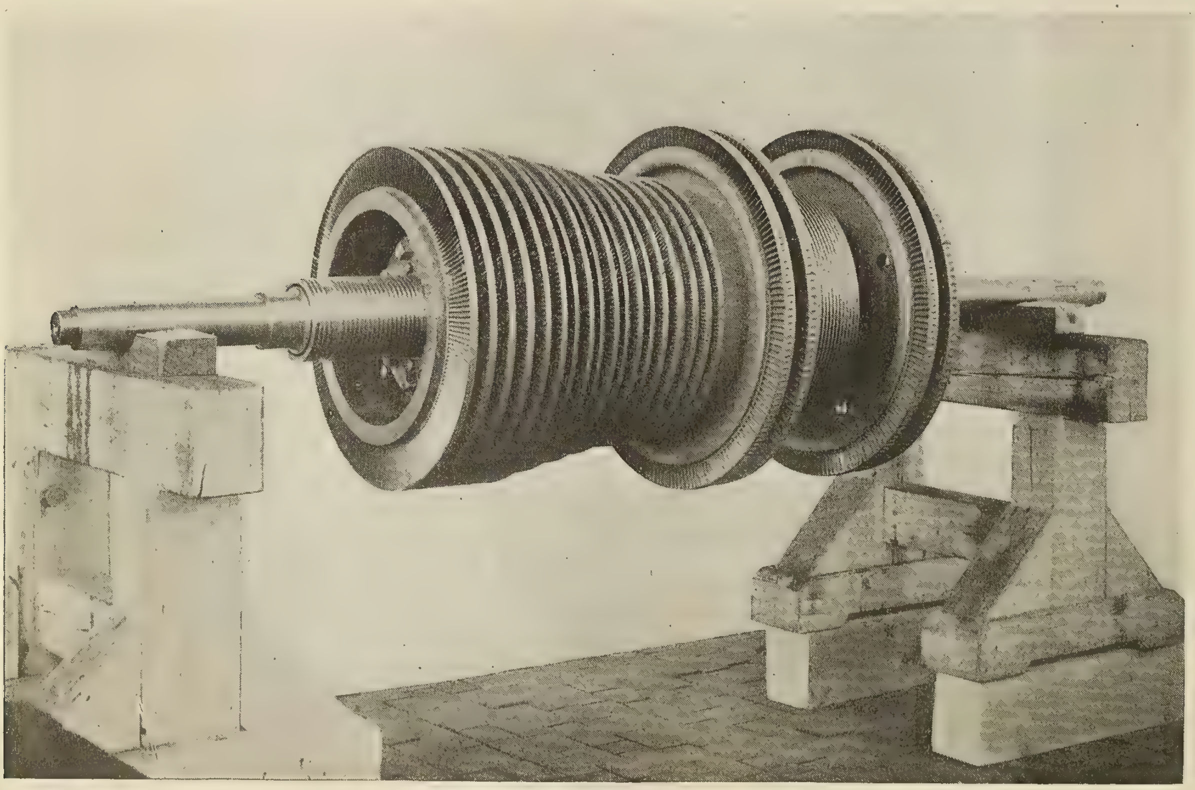


Fig. 9.—Rotor of 7,000 Horsepower Turbine

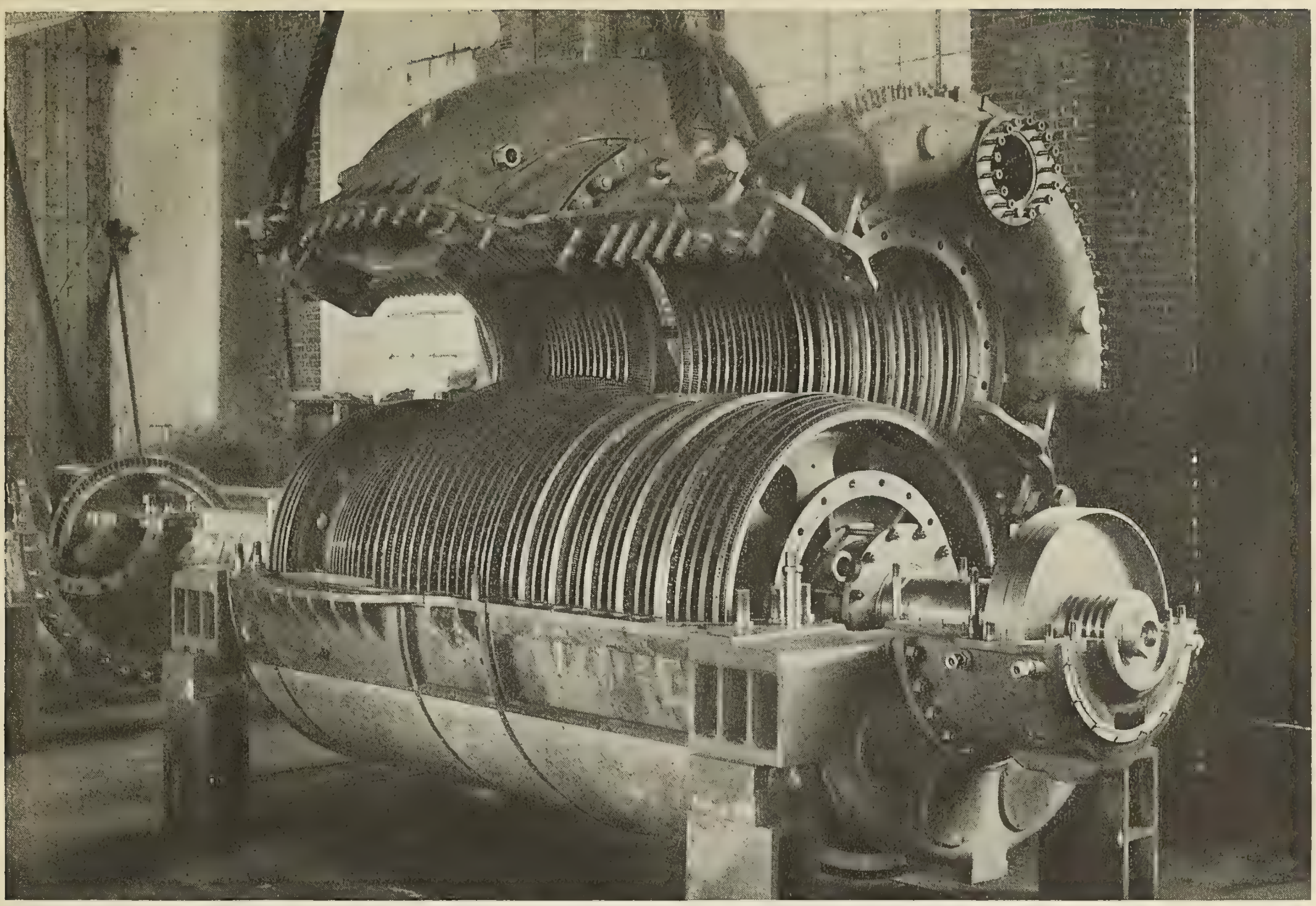


Fig. 10.—20,000-25,000 Horsepower Marine Turbine, Designed to Run at 500 Revolutions per Minute

and by means of a system of springs this piston would close a butterfly valve which is built in the steam piping system of the turbine.

The exhaust steam from all of the auxiliaries is conducted in the usual way into the low pressure turbine, but when it becomes necessary to operate the astern turbine, a special valve automatically delivers the exhaust steam from the auxiliaries directly to the condenser.

It is of special interest to note that the Tosi naval turbine has:

1. Few but very strong blades.
2. Very rigid drums.
3. Protection boxes against friction of the parts with very little clearance.
4. These turbines can be put into action very readily so that on a vessel with a 25,000 horsepower turbine starting with cold boilers it is possible to reach full speed within twenty-five minutes, as it is unnecessary to pre-heat the turbines for seven or eight hours, as in other types of turbines.

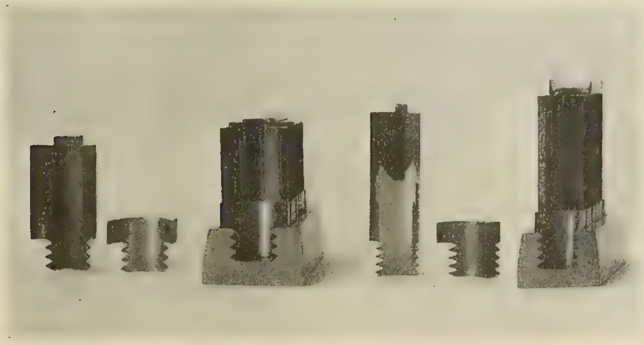


Fig. 11.—Blading from Tosi Marine Turbine

As can be seen from the general arrangement of the machinery for a cargo boat, Fig. 4, the boilers used in connection with these turbines are of the watertube type. They are fitted with a superheater and with an arrangement to heat the air from the products of combustion before the air reaches the grates.

When you have an automatic feed or anything which is supposed to work itself, it will pay to watch it. No piece of machinery thinks.

Almost any man can see if a thing is wrong. It is a good man, however, who knows how to make a wrong thing right and such a man is not to be found on the bargain counter.

It is strange to hear so often from the chief water tender that the boiler that blew up had had half a gage glass of water not two minutes before the boiler let go. That's the time when the man lied.

A fireman went to his chief and said, "I am saving you a ton of coal a day over what you have been burning, and I think I should have more pay." The chief replied, "If you are not shoveling as much coal as did the old fireman, you are doing less work, so you should not ask more pay for less work." There are many just such short-sighted chiefs, and they are the cause of many labor troubles.

Repairing German Vandalism on Interned Vessels by Electric Welding*

Damaged Machinery Repaired by Electric Welding Apparatus—No Failures in Any of the Welds—Vessels Ready When Needed

BY COMMANDER E. P. JESSOP, U. S. N.

On April 6, 1917, the interned German and Austrian vessels located in the port of New York were taken over by the collector of customs for safekeeping, the crews being interned.

The vandalism on all these vessels was, in general, the same, which would indicate that general instructions had been issued to all commanding officers by the same agent. It also appears that the parts damaged, as a rule, were those probably on hand as spare parts in the home ports of the vessels. In case this country did not enter the war the ships could be again commissioned by utilizing spare parts already provided.

Board of Railway Engineers Appointed

It was appreciated that the rapid repair of these vessels was of the greatest importance, and to that end the collector appointed a board of railway engineers to investigate the damage to the machinery to these vessels with a view to the use of electric welding where it could be done satisfactorily. This board, headed by the consulting engineer of the Erie Railroad, consisted of the electrical engineer of the New York Central, the mechanical superintendent of the Erie, one general foreman from the Erie and one general foreman from the New York Central. The railroad engineers were probably the only ones in this country who had made any extensive successful use of electric welding in connection with cast iron.

The Shipping Board had also appointed a board of engineers to inspect these vessels. The inspections by these two boards were made at the same time, although the boards worked separately. The report of the board of engineers for the Shipping Board recommended the renewal of all cylinders which were badly damaged. These recommendations were made without any idea of the use of electrical or other methods of welding, and were therefore not of any use as to time and cost if welding processes were applied. The report of the electric welders committee was unanimous in stating that all damaged cylinders could be reclaimed.

Opposition to Electric Welding

Great opposition to the electric welding of cast iron cylinders developed among certain engineers and it was with the greatest difficulty that consent was obtained for a trial of this method. With so much at stake, and considering the time element, the logical procedure would be to repair one cylinder by this method and to put this cylinder through a series of drastic tests. Unfortunately this method was not pursued, and the controversy with regard to the methods to be applied in these repairs continued until the larger vessels were turned over to the Navy Department to be fitted as transports, about the middle of July, 1917.

All told, the principle of electric welding has been applied to fifteen ships in the port of New York. Of these ships, all are in commission and will probably be ready for service before this article appears in print. In no case known to the writer will the repairs to the propulsive machinery of the vessels delay them beyond the time necessary to equip them as transports. In other words, by the use of electric welding all of the vessels will have been gotten out as quickly as would have been the case had no damage to the main machinery been done by the Germans, the vessels being in other respect badly run down and in need of extensive overhaul.

Control of Current Essential

In order to successfully weld with the electric arc it is necessary to have complete control of the current. The arc must be directed along the line of fracture to be welded. Welding must be done slowly, the metal being laid on layer by layer, and each layer must be calked and peened to knock or chip out the metal that has oxidized or hardened. Cast iron is not welded to cast iron direct. Special alloy steel wire is used to supply the welding metal. In welding two cast iron edges together a layer of steel is welded to each, and then these steel layers are welded to each other. It is difficult to weld two cast iron parts together, but comparatively easy to weld a steel piece to a cast iron piece.

The advantage of electric welding is that the work can be done without preheating the parts and without removing the parts from the ship (provided the electric arc can be properly directed along the fracture).

Mr. D. W. Wilson, Jr., vice-president of the Wilson Welder and Metals Company, Inc., of New York, gave his personal attention and supervision to the work of welding.

Repairs to the Armenia

The first vessel upon which this method of repair was tried was the *Armenia*. The cylinders were removed from the ship to the dock, although this was unnecessary. The welders were put at work welding two nozzles on the main cylinders. This particular piece of work is interesting because when finished no calking was necessary on these welds. When the first test was made some leakage developed in the weld and it was found that, due to the position of the cylinder, the welders had difficulty in reaching the points to be welded, and the work was not properly done. When the cylinders were turned over so that the operator could get at the work easily the weld was very soon completed and a test of 75 percent above the working pressure showed no signs of leakage of any description. The vessel was very quickly placed in service at a cost for this particular part of the work of about one-fourth of what had been anticipated.

The next vessel—the *Nassovia*—had almost a similar job—that is, two steam nozzles to be welded. On this work an air calking tool was used to calk the whole surface of the weld. From that time on no weld was considered satisfactory until it had been thoroughly gone over by the calking tool. It was found that on laying on the welding metal it might be porous in spots, but in addition to the necessity of closing up the porous spots the

* From the Journal of the American Society of Naval Engineers.

hammering of these welds is sure to develop any hard or brittle metal; and where any such does develop, that part of the weld is immediately cut out and new welding metal laid on. The writer believes it *essential for safety* that no weld, whether done by the electric process or by oxy-

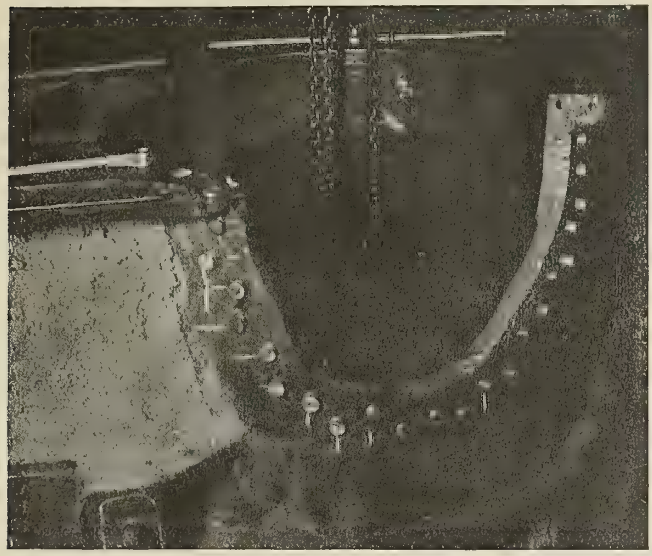


Fig. 1.—*Prinzess Irene*, Damaged High-Pressure Cylinder, Ready for Insert, Preparatory to Welding

acetylene, can be considered safe for such work until it has been hammered and the weld proved in that manner.

The *Pisa* was next welded, this being another case of welding main engine nozzles. One of the effects of the skepticism of engineers with regard to this work was shown when the *Pisa* sailed from this port to Norfolk and, on arrival at Norfolk, it was reported that the weld had given way. Investigation demonstrated that two small pin holes had shown up in the weld, from which oozed an occasional drop of water, no steam issuing whatever, but there had been so much talk of the dangers of the electric welding that the engineers of the vessel were afraid to go to sea with it. It was only after the naval engineers from the Norfolk Navy Yard had pronounced the work safe that the engineers of the ship were prevailed upon to make the voyage.

Damage to S. S. Prinzess Irene

The *Prinzess Irene* and the *Frederic der Grosse* were sent to the Navy Yard, Brooklyn, N. Y., for overhauling. The breaks shown on these engines were probably as difficult of repair as any. These two vessels have been completed and are now in the transport service. From the start no trouble has ever developed with regard to the welds after they were pronounced finished. Some of these photographs show the break after being prepared for welding; others show the cylinder with the insert fitted ready for welding, and others show the completed weld. It will be noted that the cast iron side is studded. This is not done as a necessary part of this repair, as all tests of welds made by the welding apparatus have shown practically the same tensile strength as the material which was welded. This laying over of metal on the cast iron side of the weld was merely done as a precaution and to increase the strength of the weld beyond that of the rest of the cylinder.

The welding done on the *Frederic der Grosse* and the *Prinzess Irene* is the first straight electric welding in any of these vessels. In all previous cases the skepticism of the engineers who had immediate control of deciding upon the form of patches which should be used caused them to have patches cast overlapping the cylinder walls and there bolted to the walls, so that part of the pressure was taken by the bolts and not all of it by the weld, as is the case of the *Frederic der Grosse* and the *Prinzess Irene*.

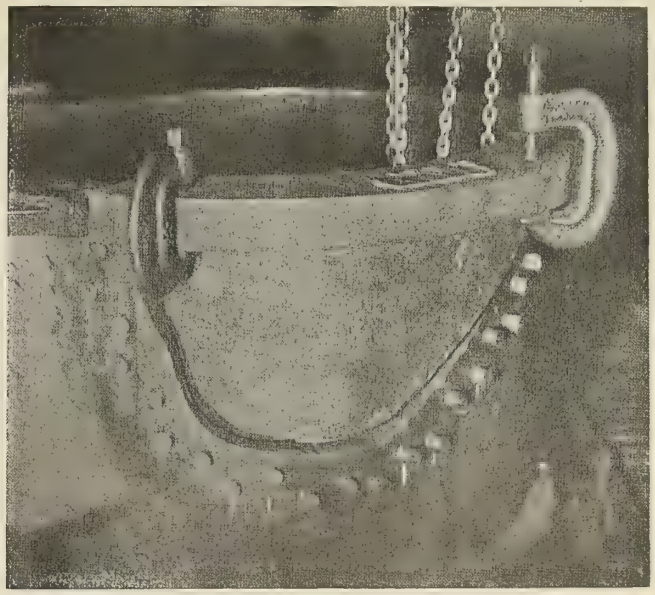


Fig. 2.—Same as Fig. 1, Insert in Place Ready to Weld

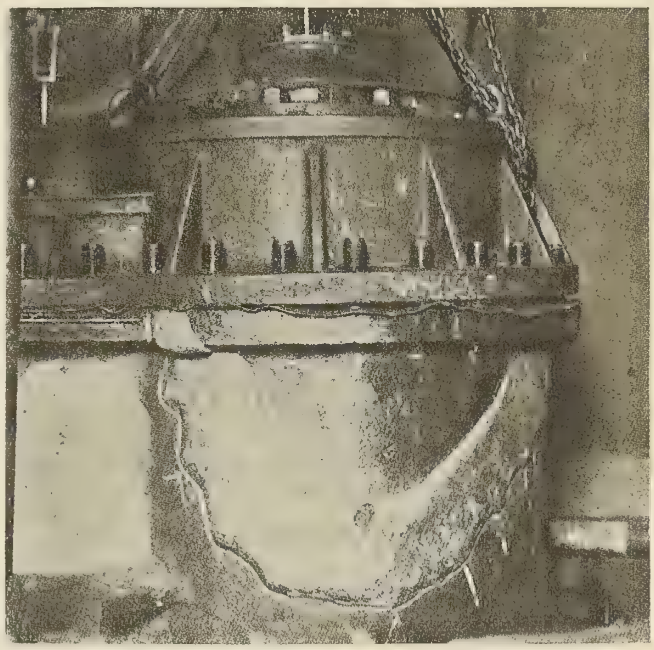


Fig. 3.—Same as Fig. 1, Finished Weld

On the *Koenig Wilhelm II* the original intention was to repair the cylinders by mechanical patches. These patches were made of composition and in most cases were in the form of inserts between cast iron sides of the breaks. When these vessels were taken over by the Navy Department all composition patches were discarded and cast steel patches substituted, but, due to the fact that the cylinders had already been tapped for the bolts of these mechanical patches, the cast steel patches were bolted to the cylinders and then welded. The amount of fitting necessary to make a mechanical patch steam tight is shown by the fact ten weeks after the *Koenig Wilhelm II* repairs had started the machinists were still at work on these patches

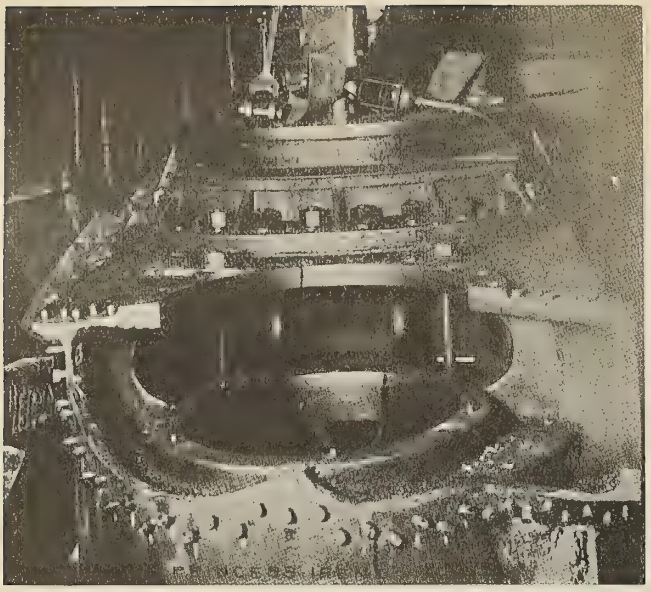


Fig. 4.—*Prinzess Irene*, Damaged Intermediate Pressure Valve Chest, Ready for Insert, Preparatory to Welding

Fig. 5.—Same as Fig. 4, Insert in Place, Ready to Weld

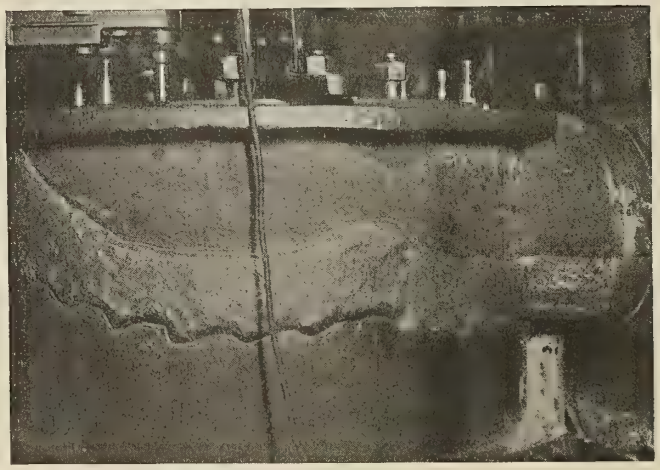


Fig. 6.—Same as Fig. 4, Finished Weld

scraping them to a fit. The difference between this method and that of welding steel patches is shown by the fact that many of the patches on the *Frederic der Grosse* and the *Prinzess Irene* were fitted in 48 hours ready for welding. In other words, they are not fitted at all, but merely beveled off to receive the welding material.

On the *Kaiser Wilhelm II* a slightly different condition was encountered, in that the liners for the cylinders in some cases had pieces broken out of them. In the case of the low pressure liners it was decided that the small area covered by the break did not justify the condemning of these liners. Therefore cast iron inserts were made and welded in place and then ground down to the surface of the rest of the liner. New liners were cast for the high pressure cylinders.

Bent Rods, Broken Pistons, Etc.

Besides the damage to the cylinders and valve chests there were some cases of bent piston rods, broken pistons, broken cylinder covers, and various other smaller items of destruction. On the *Kaiser Wilhelm II* the intermediate piston rod on each engine was badly bent, but not so badly as to preclude its being straightened and replaced. This work is now completed.

In no cases were the boilers of these vessels maliciously injured, and in very few cases were the major auxiliaries tampered with. From the methods used in disabling the machinery it would appear that the Germans had a definite plan in view, and it is very probable that all parts broken have duplicates already cast and ready in Germany to replace them at the end of the war. In a number of the ships the engines were disabled by breaking or throwing overboard the throttle valve. The procuring of new throttle valves has generally taken as much time as the repairs of the breaks to the machinery.

Case of the Vaterland

The case of the *Vaterland* is quite different from that of any other of the ships. The *Vaterland*, being the largest ship afloat and the most complicated, seems to have had inferior engineering talent operating it. Her engines are of the Parsons type of turbine, there being four ahead and four astern turbines on four shafts. All the ahead engines were found in excellent condition, and all of the astern engines were found more or less damaged. The major part of this damage seems to have been due to faulty operation and not to any malicious intent. Cracks were found in the casing of the starboard high pressure backing turbine. These were so extensive that it was palpable that the engines had not been used on the last run. This view has been corroborated since by the discovery of certain written matter on board showing that the vessel made the last trip on three propellers and at reduced speed. One crack in the lower casing of this turbine extended a distance of about 8 feet around the circumference of the steam belt. Other cracks were found in the upper half of the casing. In addition to this the dummy cylinder was found cracked in three places, all being in the wake of the nozzle box. This turbine has one stage of impulse blading, and, as the action of the nozzle boxes had evidently been such as to distort the casing and develop the cracks which were found, it was decided to cut off the impulse blading entirely. While this will reduce the economy in these engines, it is not believed that it will reduce the backing power to any extent, since more steam will be admitted to the reaction blades than formerly.

The auxiliaries of the *Vaterland* were in fair condition, as were the boilers. The vessel has 46 Yarrow boilers with closed ash-pit system of forced draft. The boilers showed evidence of poor handling. The presence of a great amount of oil shows poor marine practice, and it appears that the Germans were using lubricant in the cylinders of the auxiliaries. This practice has been discontinued in our service for many years. It is a curious

fact that, although this vessel had steam lines which in some cases extend over a length of 300 feet, she was not fitted with proper drains and traps, such drains as were fitted being run into the bilges. The boilers are not fitted with internal feed pipes, and as a result they seem to prime very easily. Internal feed pipes have been fitted.

Holes Bored in Suction Pipe

Besides the damage to the blading of the backing turbines a few minor attempts at disabling the ship were discovered. One section of suction pipe to the fire and bilge pumps was found with holes bored in it, these holes plugged up with putty and red lead and then covered so that they would not be discovered. The glands for the stern-tube stuffing box had been removed and strewn through the bilges. A great deal of water had entered the stern-tube compartment. All parts of these glands were located and replaced and the compartments cleared of water.

One of the great difficulties in carrying on the repair work of these vessels has been the lack of proper drawings and the lack of information with regard to the operation of the machinery. This has been particularly true in the case of the *Vaterland,* on account of the great mass of machinery and electrical apparatus and piping, and it has been only by the most patient and dogged following up of pipe lines and electric wiring that sufficient knowledge of this vessel has been acquired to render it safe to take it to sea.

In summing up the subject it is thought necessary to invite particular attention to the following items with regard to electric welding and its proper application. In welding cast iron it is particularly essential that the welding metal be laid on the cast iron surface with the greatest care, since it is the juncture between the cast iron and the welding metal which is liable to be inferior. To accomplish this the welding metal should be laid over the cast iron surface wherever possible before the patches are put in place. This method gives the welder more room to work and permits him to keep a steadier arc and thus reduce the probability of too much or too little heat spoiling that part of the weld. This metal as it is laid on the cast iron surface must then be peened by a calking tool in order to develop any hard spots or spots where contact is not good. After this part of the operation is completed the patches should be put in place, and the completion of the weld then is merely welding of steel to steel, which is a very simple process.

Skilled Welders Necessary

Of course, it is important in such special work as this that the operators be the most skillful obtainable. In the work which has been carried on in the German ships the operators have not been particularly skilled men in all cases on account of the great number necessary and the comparatively few who are fairly skilled in this art. For that reason more cutting out and replacing of bad metal has been necessary than would have been the case if the

Fig. 7.—Damage to *Pommern's* Boilers

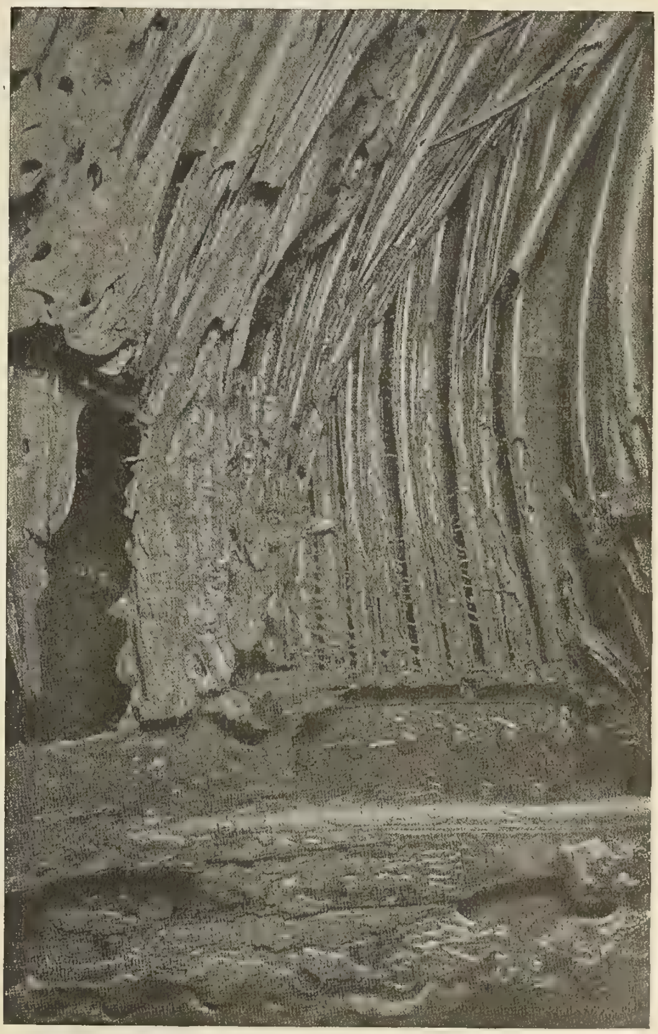


Fig. 8.—Damage to *Pommern's* Boilers

Fig. 9.—Patch Clamped in Place for Welding

work had not been so extensive and had only skilled operators been used.

It is thought to be a remarkable fact that in all the work which has been undertaken by the electric welders there has never been a failure; this in face of the fact that almost every conceivable kind of patch has been handled, and also in face of the fact that the work has been very much more extensive than any ever before attempted. I believe this is practically the first of its kind of any moment to be attempted in marine engineering. The writer's confirmed belief is that the scraping of cast iron parts of machinery is entirely unnecessary and will very soon be a thing of the past. It cannot be too strongly insisted that in every case in which this method has been used the repaired job has been fully as strong as it was before the damage was committed, and in most cases stronger in the particular part affected.

The following information regarding damaged German vessels interned in other American ports is also reproduced from the same issue of the *Journal of the American Society of Naval Engineers:*

Boiler Damage on S. S. Pommern

The S. S. *Pommern,* now the *Rappahannock,* was interned at San Francisco. When it was decided to put her in service a survey of the vessel developed the fact that of four Scotch boilers on the vessel but one could be repaired. It was necessary to renew the other three.

The accompanying photographs give some idea of the nature of the damage. The boilers were ruined by dry firing. Not satisfied with the results of this treatment, it appears that thermit or some kindred agent was employed to complete the vandalism.

The net result, however, was negligible. Considering, quite aside from the cash value, the military value of the vessel, for every ship to-day has at least a potential military value, the cost and time required to effect the necessary boiler repairs and replacement would surprise the agents that so carefully thought out the campaign of vandalism on the German vessels seized in this country.

When the *Neckar, Rhein* and *Bulgaria* were turned over to the Norfolk Navy Yard for repairs their main engine cylinders had been badly damaged by the German crews just prior to seizure of the ships by the United States Government. The ships are all twin screw and equipped with quadruple-expansion engines of the usual marine type. Of the 24 cylinders on the three ships, 17 were damaged. Of this number 15 required welding. This applies to the cylinders proper. In addition, there were several broken fittings and cracked cylinder liners. In the course of repairs the only casting which was made complete was one low pressure valve chest cover, which was so badly broken as not to warrant repair.

Repairs to S. S. Bulgaria

On the *Bulgaria* the two high pressure cylinders were damaged by having the flange to the main steam inlet nozzle broken. These two cylinders were repaired by machining off the broken flanges and threading the nozzles with a fine thread for about 2 inches. Steel plate flanges were turned, threaded and fitted to the nozzles. No welding was performed on these two cylinders, and the job tested satisfactorily.

In none of the acetylene welds did any leaks, other than one or two pin holes, show. In the arc welds leaks of various sizes developed in practically all welds, and were closed by rewelding or calking. The large weld in the *Bulgaria,* for example, was tested four times before passed as tight. In every case the leak was between the welded metal and the cast iron cylinder wall. No leaks showed where the welded metal joined the cast steel patch.

In preparing the cylinders for either arc or acetylene welding the jagged edge of the break was first smoothed off and then beveled to approximately 45 degrees; wooden patterns representing the patch were then fitted to the break in the cylinder and a cast iron or steel patch made from this pattern. The cast iron or cast steel patch, after cleaning, was fitted to the cylinder and beveled to approximately 45 degrees on the welding edge. The patch was then clamped in place for welding.

When arc welding was to be used all cast iron edges adjacent to the weld were drilled and tapped for ½-inch studs spaced about 1½ inches center to center. Two rows of studs, staggered, were employed. The theory of using steel studs is that the weld will take hold of the studs without fail and thus assure a good hold on the cast iron. Studs were, of course, not fitted when acetylene welding was used.

With the patch secured in place the arc welding proceeded by first building up the edges of the V slot from one end to the other and then filling in between these steel-

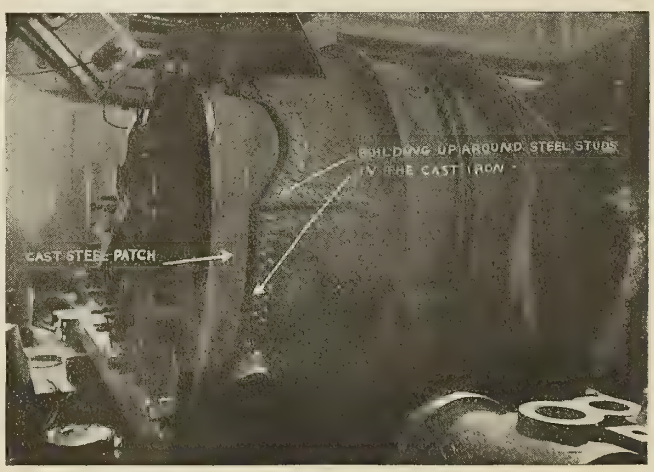


Fig. 10.—Metal Built Up Around Studs

plated surfaces with the welding material. At no time during the weld was the adjacent metal allowed to become very hot. Overheating induces shrinkage or cooling strains in the weld. These are particularly noticeable where the weld joins the cast iron. The welding material is steel wire for all arc welds.

Acetylene welding is fundamentally different in application, and, while in arc welding every effort is made to keep the vicinity of the weld cool, in acetylene welding preheating is employed and the actual filling of the V slot is done in lengths of about six inches. The sides of the slot are actually fused with the torch and small pieces of welding rod and flux added to the puddled metal. Having built up 6 inches flush, another section of the same length is then fused and filled. On heavy cast iron the weld proceeds at about eight inches per hour. By skillful manipulation of the torch and the use of flux most of the slag and other impurities are worked out of the weld. Cast iron welding sticks are used for filling in.

In order to prevent after-cooling cracks in the metal near the weld it is necessary, in acetylene welding large bodies, to employ preheating. This is most satisfactorily done with a charcoal fire built under the break. In most of the cylinders this was started about four hours before the welding. The fire is kept going all the time during the welding and is allowed to die out in place when the weld is finished. In fact, when finished, the weld, fire and all, is covered up and slow cooling encouraged.

Another point required in acetylene welding is that due to the fluid condition of the metal when the torch is applied it is necessary to keep the surface of the metal horizontal. In a cylinder, therefore, when the break is circumferential, it is necessary to mount the cylinder on rockers or, in some other convenient way, make it possible to rotate it as the weld proceeds.

As the foregoing brief description is primarily to illustrate the actual welds and not to go into the relative merits of the two methods of welding, no further discussion on that point is offered. The most important conclusion is that complicated breaks in fifteen cylinders, besides many lesser parts, were successfully repaired, and that to-day three valuable ships are in service against a country that strove in vain to render these ships useless for months.

Lifesaving Equipment for Uncle Sam's Fleet*

First Class Lifeboats and Operating Gear Must Be Provided to Meet Submarine Hazard—Motor Lifeboats Advocated

BY CAPTAIN A. P. LUNDIN

Many landlubbers have a theory that "sailors," from captains to deck-hands, can be turned out as fast as hot cakes, or, in other words, that men to run a ship can be trained like chauffeurs to run an automobile.

Any man who has had experience in navigating knows that it takes more than theoretical knowledge. I had opportunity to meet with many young men who came with fine diplomas as graduates from schools of navigation; but when it came to finding out where the ship was, one of them once had her in the middle of China when we were only a few miles from the California coast!

Besides the actual science of navigation, we must also consider the importance of good judgment at sea and when approaching land, particularly in thick or rough weather. Of course, soundings are made with the line, but a good sailor must rely a good deal on his nose and eyes. That so-called sea-sense of an old tar is not learned in a school. It can only be acquired in years of actual experience at sea.

And what is true of the chart-room and forecastle also applies to the engine room, where it is sometimes a case of keeping up steam and the engine running even with a leak in the steam pipe and hot bearings in the engine. Besides, there are many engineers who may be very experienced and capable on land, but at sea they are likely to become seasick unless they are properly accustomed and trained to the sea. Seasick engineers, navigators and sailors cannot be depended on in an emergency.

Although we may build a merchant marine in short order we cannot train our officers and men and make them physically and mentally fit to meet all emergencies with the same record speed, so it is more important than ever to take due precautions as to the lifeboat and floatage equipment in order that as many as possible of our valuable trained officers and seamen may be saved to serve their country further. The same holds true of our soldiers on the transports, and the knowledge that our boys are provided with the very best safety appliances for use in case of disaster would be very reassuring.

Now, as to what constitutes the best floatage and lifeboat equipment, this is rather a broad subject and must be taken seriously.

When it comes to saving lives, the best equipment is none too good, and results from observing the policy of "*getting the cheapest*" are often disastrous. The safety of all on board does not depend on the lifeboats alone, but on the chocking and stowing, the davits, the releasing gears—in fact, on the merits and efficiency of even the smallest detail of the equipment, and last, but not least, on the drills, which should be carried out frequently and under conditions as nearly as possible like those which obtain in case of accidents at sea, so that sailors and soldiers, as well as passengers, may grow accustomed to the handling of lifesaving apparatus under strain of excitement.

I need hardly say that I consider mechanical davits a necessity; this necessity has been recognized in the rulings made by the International Conference on Safety at Sea some years ago. And it must be a mechanical davit that permits of swinging out the boats loaded, keeps them under control at all times during launching, and, above all, with sufficient power so that the boats on the high side of

* From an address before Marine Section of American Society of Automotive Engineers, New York, January, 1918.

the ship, in case of a list, will not be useless. Moreover, it must be simple to operate and have no intricate parts that can be put out of business by weather conditions at sea.

The chocking is also very important, and even seconds count when it comes to releasing the boats in time of danger. Before the war, when passenger traffic was heavy, our ocean liners had to carry "boats for all," and to save deck space the so-called pontoon boats, built of flimsy material, were stowed under the regular lifeboats. But this type of boat is not strong enough to support the open boats without extra heavy shocks, made up with the help of beams, stanchions, bolts, etc. Of course, it takes a long time to release such boats, and even at best they are not very reliable for lifesaving.

Light Rafts Preferred to Folding Boats

I much prefer a light raft to these folding contraptions of easily deteriorating material, for the former can be easily thrown overboard if it comes to the worst, and will serve as an emergency support for those who are swimming or floating about with only a life preserver to save them from drowning.

The most important of all modern improvements in the field of lifesaving equipment is the motor lifeboat. A couple of years ago a new law was passed requiring all passenger ships under the American flag to be equipped with at least one power lifeboat. In my estimation, it is just as important that every cargo ship should be equipped with one likewise. At that time there was a difference of opinion among captains, navigators and seamen generally as to the value of a power lifeboat.

The reason for this may be sought in human conservativeness when it comes to new things. In this respect the sailor is apt to be as cautious as the landsman.

Ideal Motor Lifeboat

An ideal motor lifeboat should be so constructed that it can be launched under davits and also without davits, or, in other words, in a case where the ship sinks quickly, the crew can get right into the boat, and when the ship goes down the motor boat will take care of itself. Being built of steel with very large, thick Balsa wood fenders on the outside, it cannot be crushed in, and, having a beam of at least one-third of the actual length and a great deal of excess buoyancy, it cannot be swamped or capsized, and even if it should turn over—which might occur if it were hit by a spar or smokestack with tremendous force—it would soon right itself.

In such a lifeboat the power plant becomes of extreme importance, for the reason that in order to make such a boat efficient it will necessarily become somewhat large and heavy, and it would be almost impossible to handle such a boat with oars in a heavy seaway. Besides, by having power such a boat will become more or less a mother-ship to the other lifeboats, and they can be towed and kept together instead of drifting apart and getting lost.

Such a power boat can carry more food and provisions than the other boats, and help them out, and when the weather is stormy and cold the people in a housed motor boat will be protected against the sufferings of exposure to wind and sea.

The motor lifeboat does not have to be a boat of high speed, and in choosing the engine I advocate the heavy-duty type, which is always more reliable. The engine should be well protected in a separate steel trunk, so as to insure against engine trouble owing to the effects of salt water. The propeller should also be protected, preferably in a tunnel, so that it will not easily get bent or twisted out of shape, as when the boat is being launched or floated off. I consider this very important, even to the extent of sacrificing a little speed.

For the average freight ship I would recommend a boat 28 to 30 feet long, which in most cases would take care of the entire crew. Let us take, for instance, a 28-foot boat for the smaller freighters. This would have a capacity of forty to fifty persons, and in emergencies could take care of double the number. Its fuel capacity is about 150 gallons. Figuring on a 24-horsepower, heavy-duty engine, this would carry it about 300 miles at an approximate speed of six or seven miles per hour. The total weight of such a boat would be about 9,000 pounds, and considering that we have davited boats of 50 to 60 tons, without trouble, this could be readily taken care of as far as launching is concerned.

Of course, such boats are somewhat expensive compared to the ordinary lifeboat; but even if such a boat costs a few thousand dollars, what does it matter if by its use a few more lives can be saved? *Actual lifesaving should be the prime consideration to those entrusted with the equipment of our ships.*

Safety the First Consideration

Everybody in the country realizes the importance of ships, more ships and still more ships, but very few think of the safety end, apart from the ships themselves—except those who have to man them. If they had their say they would not hesitate to demand the best that can be obtained. They realize that we are at war. War at sea is worse, if anything, than on land, and we need every precaution that can be taken.

It is strange that, although insurance companies and underwriters keep a very accurate record of improvements in fire-extinguishing apparatus, pumps, boilers, engines, etc., just as architects and fire underwriters for buildings have a most explicit rating on fire protection, elevator systems, etc., yet the former are concerned only with the cargo of ships and the saving of property, whereas very little attention is paid to the kind or quality of lifesaving equipment that is carried on the ships with a view to safeguarding the crew.

Considering the fact that our Government is now taking the lead in underwriting the ships and lives that cross the war zones, I think it would be well for everybody responsible and concerned with the matter to do their bit towards avoiding loss of life and set premiums in accordance with equipment. Now is the time, if ever, to protect and shield those valuable men who have to go through years of training, and the shield we hold over them should be made up of wisdom on the one side and virtue on the other. Wisdom is knowing what to do next, and virtue is doing it.

A cool drink for the fireman gives better results than a hot cussing.

Give the men in the boiler room all the fresh air possible. It is good for them and the fire.

When something happens in a boiler which no one can explain, it is poor policy to say it is a mystery and let it go at that. Find out the reason or you may become one who has solved the oldest of all mysteries. The notice may read, "Please omit flowers."

Fig. 1.—Row of Four-Room Houses for Shipyard Workers

Gulf Coast Shipyard Solves Housing Problem

Model Village Built by International Ship Building Company—Hotel and Workmen's Cottages Designed Along Homelike Lines

WHERE a pine forest stood six months ago a model village is to-day being established at the side of the plant of the International Ship Building Company, one mile from Pascagoula, Miss. Landscape artists, engineers and architects have contributed their talent toward the most attractive and practicable arrangement of streets and dwellings. Modern municipal improvements, electric lights, water and sewerage are being installed. A natural park near the center of the town will be further beautified with plants and shrubbery. An amusement and recreation hall, with reading and billiard rooms, shower baths and other conveniences and comforts, will be provided. Workmen's cottages, three, four and five rooms in size, of which there will be 300, a number already completed and occupied, are designed along artistic and homelike lines. Each house is made to differ somewhat in exterior appearance. A two-story hotel is about ready for the accommodation of officials of the company, workmen without families and visitors. An experienced man will be employed permanently to see that streets and lawns are kept in good condition.

Well-Housed Workmen More Efficient

Both practical and altruistic motives have inspired the company in undertaking a housing plan of such magnitude.

"Aside from its purely industrial features," says H. H. Roof, general manager, "a shipbuilding plant such as ours is primarily a human institute, an organization made up of a number of men, an aggregation of individuals affected by good or evil influence that reflect themselves in the general morale of the force and its efficiency or inefficiency.

"It therefore follows that whatever is good for the individual must necessarily be good for a collection of individuals, for a company or a corporation.

"We are looking after the welfare of our men, first, because it is our duty as employers of labor to see that our

Fig. 2.—Hotel Built for Accommodation of Shipyard Workers

Fig. 3.—Popular Type of Workman's House. Designs Varied to Suit Taste

employees are provided with clean, comfortable, wholesome surroundings; that they are furnished recreation and amusement of the proper kind for their idle hours; that they are afforded every opportunity for the full development of the best that is in them. A man worth anything at all is worth taking care of.

"The well-housed, contented workman is more efficient than his ill-cared-for brother, and, even though nothing else were taken into consideration, it is my belief that from the standpoint purely of dollars and cents it is the best sort of investment that any company could make to invest in satisfied and loyal employees.

"An employer will be very shortsighted if he fails to also realize that we are approaching the time when there will be a serious labor shortage in the United States. And labor is going to stay with the man and the company which appreciates the service of the good workman and takes a genuine, sincere interest in his welfare."

Housing Investment Nets Company Good Revenue

The four-room California bungalow type appears to be the house in greatest demand among the shipyard workmen. This cottage consists of kitchen, dining room, living room and bedroom, with bathroom and pantry off kitchen (rooms about 12 feet by 14 feet), fireplace and mantel; front and rear porches, electric lights and water connections. Owing to the comparative cheapness of Southern pine lumber and its ready availability in large quantities, this type of house can be built for about $600 (£123). The house rents for $3 (12/6) a week, or $156 (£32) a year, 26 percent of the original outlay, exclusive of cost of ground, which is small.

A somewhat more pretentious structure is the standard five-room house, papered and weatherboarded, the cost of which is between $1,100 (£225) and $1,200 (£246). This house rents for $16 (3/6/8) a month. It has the same conveniences as that mentioned above, and in addition two fireplaces, or, where fireplaces are not provided, facilities for four stoves. The rooms are 13 feet by 14 feet.

The three-room house is built along simpler lines, and is not equipped with bathroom.

All houses are placed sufficiently far back from the street to allow space for front lawn, and each has a garden plot in the rear, with shed.

The real showplace of the village is the hotel, two stories high, the exterior of the first floor being stained up in California bungalow style, the second story weatherboarded. The hotel has 52 bedrooms, in addition to lobby, dining room, kitchen and bathroom. There are two big granite fireplaces, one in the lobby, the other in the dining room. The lobby and dining room are beamed, with panel wainscoting up about five feet. All bedrooms except two have outside exposure, with at least two windows each. The rooms are ceiled and painted, with electric lights and wall switch in every room.

Plans for any of the above houses and hotel may be obtained from the Southern Pine Association, New Orleans, La.

New Wooden Shipyard Started in Quebec

Ideal Location for Building Wooden Ships Found at Three Rivers—First Keels Laid in Zero Weather

The Three Rivers Shipyards, Ltd., of Three Rivers, Quebec, Canada, was organized in the summer of 1917 by T. M. Kirkwood, of Toronto, president and general manager, and William T. Donnelly, of New York, vice-president and consulting engineer, after a very careful and thorough investigation of the possibilities of developing wooden shipbuilding in Eastern Canada as a permanent industry.

The city of Three Rivers is located at the outlet of Lake St. Peter, on the St. Lawrence River, about half way between Montreal and Quebec, and this location has many remarkable natural advantages for shipbuilding, including the following:

A natural deep water harbor, without dredging or artificial work of any kind.

Less difference in water level either from tidal or flood causes than any other location in Canada; an extreme of 4 feet and a usual variation of about 2 feet. This small variation is of the utmost importance in relation to the launching of vessels and their protection from flood while under construction.

A careful investigation of the labor conditions in and about Three Rivers convinced those interested in the enterprise that the sturdy Canadian woodsmen of the past still made his home in and about Three Rivers, and that his far-famed skill with the axe was not a thing of the past.

A careful survey of the adjacent region to the north of Three Rivers, extending up to the new trans-continental line, made certain that there was in Eastern Canada a large and dependable supply of native wood suitable for the

Fig. 1.—General View of Three Rivers Shipyard from Waterfront

Fig. 2.—Erection of Plant Begun

Fig 3.—Building Ways

building of wooden ships of the larger size for a period of many years.

Finally, the city of Three Rivers has one of the best and most dependable sources of electric power available anywhere, and there is to be found in this city a combination of industries which, taken together, will support and aid a shipbuilding industry.

As a final consideration, those having the enterprise at heart received a most thorough and hearty welcome and support from the mayor and officials of Three Rivers.

A contract was received from the Imperial Munitions Board for two wooden vessels of 2,700 tons deadweight. The keels for these vessels were laid on November 3, and the first frame put up on December 21. In spite of the most severe weather Canada has known in more than a generation, the work proceeded in the open without interruption, and on January 26 hull No. 1 had 43 frames erected, and hull No. 2 26 frames.

Credit for this excellent progress is due to the hearty and loyal French-Canadian woodmen of Eastern Canada, backed up by a thoroughly modern and complete mechanical equipment, protected by a building constructed to meet the severe climatic conditions of Eastern Canada. Within this building, which is 168 feet by 75 feet and thoroughly steam heated, all machine and tool work proceeds without interruption during the most severe weather. A mold loft 168 feet by 50 feet gives ample room for laying down lines and taking off forms. All tools are operated by individual electric motors of ample capacity. A separate building houses an electrically driven air compressor of ample capacity.

To properly care for its staff of workmen, this company

Fig. 4.—Work Continued in Zero Weather

Fig. 5.—French-Canadian Woodmen Make Excellent Shipbuilders

Fig. 6.—Interior of Mold Loft

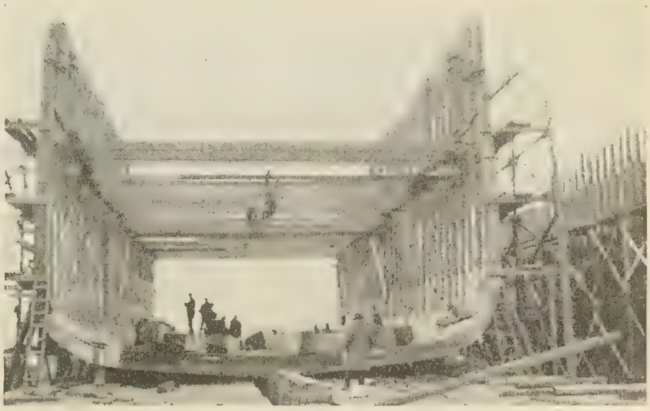


Fig. 7.—First Vessels in Frame

has provided a bunk house 50 feet by 25 feet, thoroughly heated, where the men can spend their lunch hour under homelike conditions. As a further recognition for good service rendered, the company has replaced the familiar water-pail and dipper by hot coffee served the men at work twice a day.

While the company have made a start with only two vessels, it is developing a staff of workmen so rapidly that other keels will be laid as soon as the Northern winter begins to lessen its severity, and there is every reason to believe that the foundations of a perma..ent and successful wooden shipbuilding industry have been laid at Three Rivers.

This company has acquired all the rights for the Province of Quebec, under patents granted to William T. Donnelly, of New York, for dry docks, new method of wooden ship construction and other marine devices, and Mr. Donnelly is to act as vice-president and consulting engineer for the company, with a New York office at 17 Battery Place.

Preventing Waste of Coal in Boilers*

Alternative Methods of Eliminating Losses Due to Inefficient Operating Management—Educational Plan Advocated

BY DAVID MOFFAT MYERS

WHILE organized effort to bring about efficiency in the production and distribution of coal is being made, no parallel measures have been adopted to bring about a normal and practicable efficiency in its use. The hundreds of large plants which are consuming fuel wastefully, in many cases more wastefully and carelessly than ever before, are directly and needlessly causing a large fraction of the existing car shortage. They are overloading the already strained capacity of the railroads; they are rendering slower and more difficult the transportation of food and other vital commodities, and, in short, they are simply counteracting the measures of efficiency in production and distribution which have elsewhere been established.

Preventable Waste of Fuel

The preventable waste of fuel in the boiler furnace of one steel mill amounted to 40,000 tons per year, which at \$5.00 (1/0/10) a ton would cost \$200,000 (£41,000). This was a comparatively modern plant. The efficiency of boilers and furnaces in a 14-day test was 55 percent. The load factor was unusually favorable to high efficiency and could readily be raised to 70 percent or over. This is only one example, and there are many more extreme cases. In one hand-fired plant the evaporation was raised from 6 to 9 pounds in a few days of instruction, and continuously kept close to this higher mark with the help of coal and water measurements which were inaugurated. The saving was due exclusively to instruction and consequent better operation.

The saving or wasting of one-fourth of the coal consumption of any industrial plant depends entirely upon the efficiency of its operating management. Let me emphasize that this fraction of the consumption relates exclusively to the boiler plants; i. e., the production of steam; and does not include the large economies possible in connection with its distribution and use.

For well-known reasons the boiler plant offers the more lucrative field for producing economies, and these with a minimum of alteration in physical equipment.

Under present conditions a plant which carelessly operates at an efficiency of 40 to 50 percent receives from the Government the same consideration in the delivery of coal as the one whose efficiency is 70 to 75 percent. This obviously is unfair as well as wasteful.

The Government hands over, say, 200,000 tons of coal a year to a plant owner, but asks for no account as regards its consumption, nor any questions as to the amount of steam it is made to produce. There is nevertheless an equivalent amount of steam this fuel is capable of generating, and it can and should be made to produce that quantity.

Conservation Methods

In general, there are two plans of operation worthy at least of consideration. One might be termed the autocratic method. This would involve the use of authority to compel coal consumers to execute such measures of economy as the proper authorities might prescribe for any given case. Limits to be set as to expense to the user. Such limits might be in terms of a percentage of their present yearly coal bill. Alterations to be directed chiefly, as previously implied, to purely operating improvements. Many objections would probably be made by consumers against this plan, but once in effect the majority would no doubt realize its pecuniary advantage to themselves. But its tendency may be too strongly opposed to democratic principles.

The other plan would be largely an educational one, in which patriotism and efficiency would furnish the motive forces required.

The teaching must be accomplished with the utmost simplicity and directness. Above all, it must be in such form as to be readily comprehended and applied. This is a big task, but with the technical and executive ability represented in this society these things should be, and can be, accomplished.

The requisite information must reach the owners and managers of industries, and there must be simple instruction sheets for the engineers and firemen. The vital importance of daily accurate records of coal and water must be taught and information given regarding practical appliances for automatic measurements of both.

Blank forms might be sent in advance to plant owners in order to be advised by them, first, whether they would be willing to co-operate with a governmental organization offering to assist them in reducing their coal consumption,

* From a paper on "Preventable Waste of Coal in the United States," read before the American Society of Mechanical Engineers, New York, December, 1917.

and second, to obtain such data as to size, type, equipment, operation and fuel consumption of the plants as would enable a classification which would permit a Government board of experts to send such instructions as would include the information needed for any one class of plants.

This work would be greatly aided by a staff of experts ready to visit plants when so requested by owners and make investigations and recommendations and keep in touch with the progress of economies. Included in such a staff should be men intimately familiar with practical operating economies, whose duties would be the delivering of lectures or talks, which should be planned so as to reach directly not only managers and owners of the industries, but also the chief engineers and firemen of the boiler plants. This feature of the plan, by itself, would undoubtedly result in great savings.

The U. S. Bureau of Mines has for a number of years engaged in obtaining and disseminating scientific information regarding the mining and consumption of coal, and the results of the work have been of great value to technical engineers who are able to use and apply it. It is evident that we now require an extension of the idea of education, but in such form as directly to affect the men who run the boiler plants of our country, for in their hands is the saving or wasting of one-fourth of our fuel supply.

Six hundred million tons of coal were mined in the United States in 1916. If we assume only one-half of this to have been used for our industrial boiler plants, then a quarter of the coal used under boilers amounts to 75,000,000 tons per year. It is worth while to save this fuel by preventing its waste. This quantity of coal represents the use of 1,500,000 fifty-ton freight cars.

Remarkable Growth of Isherwood System of Ship Construction

In spite of the practical abolition of shipbuilding for private ownership, the Isherwood system of construction has made marked progress during the past year. No less than 180 vessels, aggregating in deadweight carrying capacity about 1,334,000 tons, have been ordered to be built on this system since the end of 1916. The grand total since 1907 now stands at 800 vessels, aggregating 6,000,000 tons deadweight carrying capacity. The following statistics show the remarkable progress which this system has made in the comparatively short period of ten years:

			Tons Deadweight Carrying Capacity
Sept., 1907, to Dec., 1908....	6 ships,	aggregating	31,608
1909..........................	36 "	"	212,992
1910..........................	76 "	"	484,752
1911..........................	140 "	"	958,795
1912..........................	240 "	"	1,777,348
1913..........................	270 "	"	1,993,034
1914..........................	311 "	"	2,351,322
1915..........................	468 "	"	3,548,221
1916..........................	620 "	"	4,666,000
1917..........................	800 "	"	6,000,000

While the Isherwood system has been adopted almost universally for oil tank steamers, and to a very large extent in the case of general cargo vessels, it is eminently suitable and advantageous for all types of boats, as is evidenced by the following analysis of the 800 craft referred to above:

			Tons Deadweight Carrying Capacity
General cargo vessels, colliers and ore steamers and passenger vessels........	386,	aggregating	2,891,600
Great lake freighters....................	24	"	279,600
Oil tank steamers........................	310	"	2,800,000
Barges	77	"	26,800
Dredgers, gross register tons............	2	"	760
Trawler, gross register tons.............	1	"	570

In great Britain and Japan the growth of the system still goes on with great rapidity.

Producer Gas Plant Proves Economical on Harbor Work Boat

OPERATING on less than 1 pound of coal per horsepower per hour, the 65-foot motor boat *Isaac Fass* is proving one of the most economical motor boats operating in Chesapeake Bay and its tributaries. The vessel has a capacity of carrying 1,500 bushels of oysters and is equipped with a 90-horsepower gas engine manufactured by the Rathbun-Jones Engineering Company, Toledo, Ohio, which operates on producer gas furnished by a 100-horsepower gas producer manufactured by the Nelson

Motorboat *Isaac Fass* Operates on Producer Gas

Blower & Furnace Company, Boston, Mass. The boat has a speed of 12 miles per hour and uses on an average 75 pounds of coal per hour at full speed.

The engine is air started, and when put in operation the plant is automatic except for charging the producer with a small amount of coal from time to time and taking out a small amount of ash. The cost of operating this plant is equivalent to using gasolene (petrol) at 2 cents (0/1) per gallon, or steam coal at $1.25 (5/2½) per ton. The engine requires less than half the amount of lubrication required by engines using gasolene (petrol), kerosene (paraffin) or other liquid fuels. The insurance rates are one-third less than for a gasolene (petrol) boat.

To put the plant in operation the time required is from 10 to 20 minutes, depending upon the length of time the plant has been standing-by and the amount of draft left on the producer. Although the engineer of the *Isaac Fass* had had no previous experience with producer gas plants, he has encountered no difficulties in operating the plant, and says he prefers the producer gas plant to a gasolene (petrol) or heavy oil engine.

A dirty or ill-kept fire room generally means a poor fireman.

When your water gets low do not try to pump it up too quickly, especially if the feed water is cold. Better yet, do not let your water get cold.

When you slice or haul your fire shut the door into the engine room. The dust of ashes is about as bad as emery on the moving parts of machinery.

Letters from Marine Engineers

Discussion of the Designs and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs,

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Repairs to Evaporator Ram Pump

While running at sea our evaporator pump broke, as shown in Fig. 1. As a quick repair was necessary, it was carried out as follows:

A piece of pipe was selected, filed smooth and made to fit the gland and neck bush. An ordinary collar was screwed to the top of same and drilled to suit the crosshead pin. It was also cut out to form the jaws. Two short

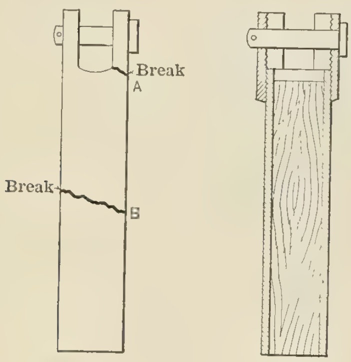


Fig. 1 Fig. 2

pieces of pipe were used to make up the distance from the inside of the collar to the width of the connecting rod head. The pipe was then plugged with wood, which swelled out, making a good job.

The pump, as repaired, carried through a voyage of twenty days and was still good when taken out for permanent repairs.

San Francisco, Cal. A. B. Blundun.

Marking Tools

Often the marine engineer and machinist gather during their cruises a number of personal tools, such as calipers, micrometers, wire gages, steel squares, scales, etc., to aid them in their work. Many ships have well-stocked tool lockers, but in spite of that, lots of the boys like their own personal tools, and each one, of course, wants to mark his name or initials on these to avoid mixing them up with the ship's tools and to provide a means of recognizing them.

For the accurate and delicate tools, the name must be etched into them with acids, for the use of steel name stamps would ruin them. The formula given below has been successfully used by a number of friends for this work.

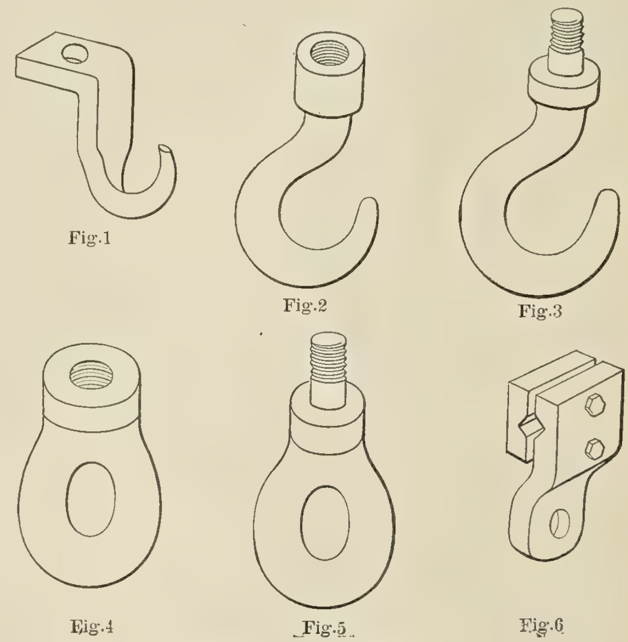
One ounce of common salt; one ounce of copper sulphate; one-fourth ounce of alum sulphate; one-half ounce of zinc sulphate; four ounces of distilled water. These chemicals are well mixed and put into a bottle, then shaken until well dissolved.

The tools are polished clean and bright at the part to be marked, and then this place is smeared with good soap or covered with beeswax thick enough to scribe the name in with a tool scriber. After the name is clearly inscribed, shake the mixture well again and pour into the tracing enough to fill it well; let it soak until the name turns to a copper color; then moisten the soap with water and clean it off. The owner's name is then indisputably imbedded on his tools in his own handwriting.

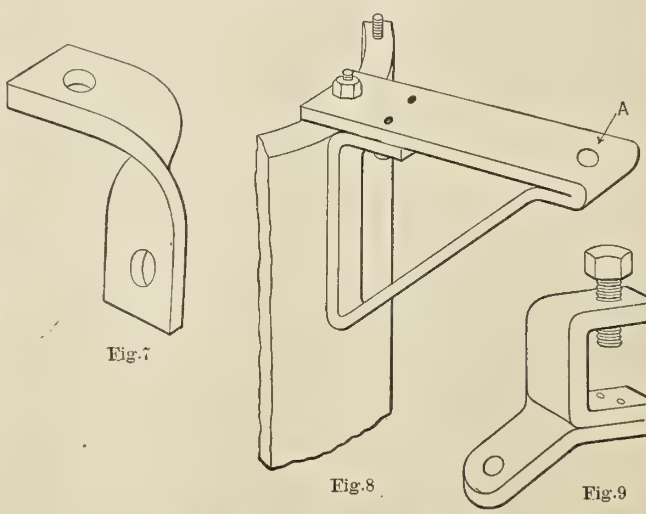
A. Tool.

Handy Rigging Helps

The various hooks and devices shown in the sketches of this article are almost indispensable for use on board ship in the various classes of engine and machinery overhaul work, for rigging the differential or chain falls, and for



Hooks and Eye Bolts



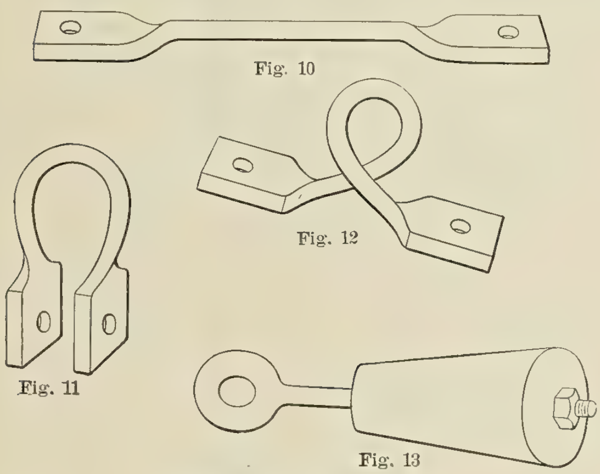
Right Angle Strap, Chain Fall Bracket and Clamp

lifting. They are all home-made products that can be easily made by the ship's blacksmiths and machinists.

Fig. 1 represents an angle hook; Fig. 2, a female hook; Fig. 3, a male hook; Fig. 4, a female eye nut; Fig. 5, a male eye bolt; Fig. 6, a beam clamp; Fig. 7, a right angle strap; Fig. 8, a cylinder wall chain fall bracket, the hole at *A* receiving the hook of the falls. Fig. 9 shows a very rugged type of clamp made from ¾ by 1½-inch flat stock, bent as shown. The lower jaw is riveted at *A*. The hole in the ear *B* is for the chain fall hook. This is an original idea with the writer and it has served him very well. Having made the clamp in various heavy sizes, it permitted the easy rigging of the chain falls in places previously difficult.

Fig. 10 shows the first appearance of the forging for making the clevis strap, Fig. 11, and the eye strap, Fig. 12.

Fig. 13 is a common long eye bolt and a tapered bushing. This is useful for easy self-centering of the bolt in holes



Clevis Strap and Eye Strap

too large for it and avoids the use of washers. We use it in the stuffing boxes when working on a large job of overhaul.

When an engineer has an assortment of such tools as these, his labor is lightened and shortened to a great extent. Ring bolts, steel rings, cable slings, straps, washers and a plentiful supply of bolts and nuts make his rigging outfit complete, and the work of slinging and lifting of everything from the crank brasses and connecting rod to the thrust block becomes easy.

Directions as to the making of these tools seems unnecessary, since the sketches are quite plain, and the knack all lies in the forging and machining.

Concord, N. H. C. H. Willey.

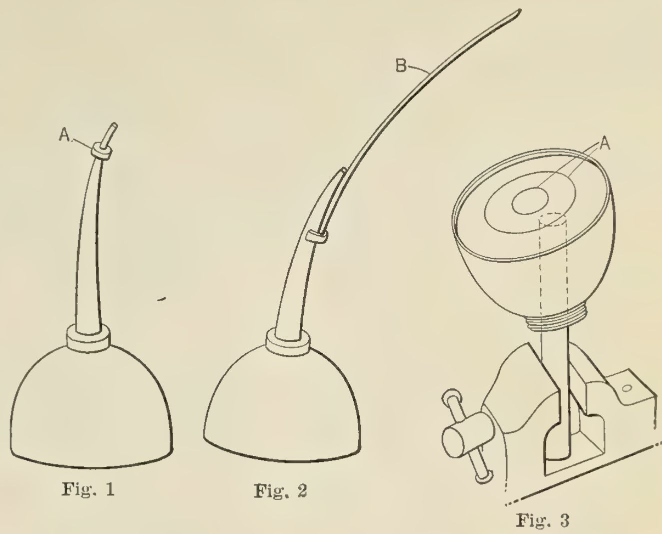
Oil Can Kinks

Often when oiling some moving rocker arm or like part of an engine, one sticks the snout of the oil can into the oil hole and it becomes jammed or bent. This is because the tip or snout goes into the hole too far.

If a small metal washer is soldered on the spout as shown at *A*, Fig. 1, this will prevent such trouble.

By soldering a piece of stiff brass wire to the end of the oil can spout, as shown in Fig. 2, the oiling of parts out of ordinary reach and accessibility is made easy. The oil will impinge and run down the wire.

Often after considerable use the spring bottom of the oil can becomes lifeless and deflected upward, rendering the can quite useless. When this occurs, just try the kink shown in Fig. 3. Take a hardwood stick or bit of round brass stock that will enter in the mouth of the can, and round up its top. Place in the vise, and put the can on it



as shown. Now, by applying a slight pressure and revolving the can around alternately on the circles, *A*, many times, the bottom becomes depressed again and new temper or life is found to be given the bottom. Oiler.

Two Lathe Kinks

These two kinks are quite simple and are taken from my notebook to be passed along to the fellow who likes to spend some of his odd time in the ship's machine shop making things that are useful.

Fig. 1 is called a lathe dog wrench plate. It is made out of a piece of ½-inch boiler plate. The tapered slot

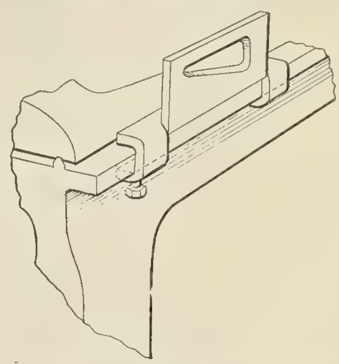


FIG. 1. LATHE DOG WRENCH PLATE

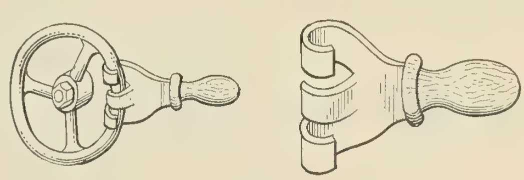


FIG. 2

Spanner

is made of suitable dimensions to take the range of sizes of set screws of the shop's lathe dogs. The plate is cut and bent as shown, and the two jaws are drilled and tapped for the securing screws.

The use of the plate is quite simple. The set screw

of the dog is placed in the tapered slot and forced up to the small end till it is gripped tight, and then the dog is unscrewed or tightened, as desired.

Often when chucking out or drilling a piece of work the continuous hand strain of feeding the tailstock center by the small hand wheel becomes tiresome, and the usual stunt to give more leverage is to apply a monkey wrench. While this serves the purpose, it mars or nicks up the wheel, and then again there is not always a wrench handy.

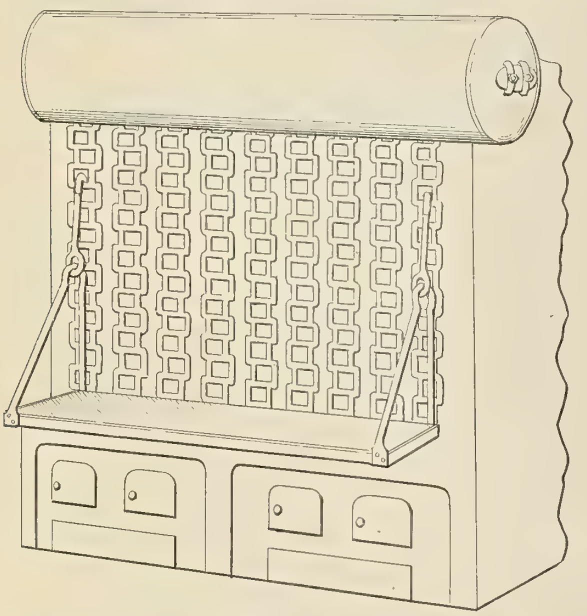
Fig. 2 shows a small spanner made from ¼-inch plate steel, one end being bent to grip the wheel, as shown, and the other end cut to a tang shaped like a file, and on this a wooden file handle is driven. The spanner is short enough to clear the latheways, yet gives sufficient leverage for easy applying of the drill pressure by the tail stock center.

MARINE ENGINEER.

Boiler Cleaning Platform

The sketch shows a very handy portable boiler cleaning platform that we have used for the tube cleaning work of our Babcock & Wilcox boilers.

The framework consists of 1½-inch angle iron. Into this are laid 2-inch planks. The hangers or brackets are



Portable Platform for Use in Cleaning Boiler Tubes

of ¾-inch round iron. These are bent to the shape shown and the hooks are made to hang over the edge of the upper manhole, as indicated. These hooks are covered with brass pipe to protect the edge of the handhole.

A platform like this is adjustable to the various heights by shifting the hooks to the higher or lower handholes.

FIREMAN.

Forced Lubrication on a Thrust Block

The value of a continuous flow of lubricating oil to a bearing is, of course, well known, but too often not realized. On a suction dredge which the writer had to do with some little time ago there were twin centrifugal dredging pumps with impellers of the open type, driven by a pair of compound engines.

The job was practically new; but the pump thrusts gave trouble from the start and heated to such an extent that it was necessary to put the water service on. The thrust shoes were solid, with babbitt on each side, and the water simply sprayed on them. A plentiful supply of water kept the temperature down and enabled the job to run; but as the water was loaded with sand, it soon made a sad mess of the babbitt and the thrust collars, which were forged solid with the shaft.

The case was considered carefully, and the conclusion come to was that the thrust load was excessive; that is, it was more than could be taken care of by the means of lubrication provided. Continued use of the water service would put the shaft on the scrap pile in a few months. It was therefore decided to fit the thrusts up with forced lubrication.

The troughs under the thrust shafts were tapped and piped to a tank located as low in the ship as possible. The tank was made of galvanized iron, and was provided with a strainer and a cooling coil of pipe, through which sea water circulated. It is quite possible that this coil could have been dispensed with; but this was not known at the time of installation. The strained oil compartment of the tank was connected to a 3-inch by 2-inch by 3-inch duplex pump, which discharged directly to the thrust shoes. The connection was made by tapping out the original oil holes. As the thrust was always in one direction, one pipe to each shoe was sufficient. Small cocks on each pipe provided a means of regulation, which could be observed by the amount of oil welling up between the shoes and the collars. An additional strainer, made by securing several disks of gauze in a large union located in the discharge to each thrust, caught all the fine particles of fluff, etc., which would otherwise have choked the oil ways in the shoes.

The pressure under which the oil was delivered was not ascertained; but it was not likely more than about 20 pounds per square inch.

That the investment was a good one is proved by the fact that it is now some years since the job was done, and there has been practically no wear, although for part of that time the dredge was running eighteen hours per day. Of course, it was necessary when doing the job to true up the shaft collars and rebabbitt the shoes, the babbitt in the latter being heavily charged with sand picked up from the water.

N. Vancouver, B. C. A. F. MENZIES, Mechanical Engineer.

Why He Wasn't Promoted

He wasn't promoted, for he was content
To be second rate—not at all diligent—
Lacked heart in his work—watched the clock very close—
Grumbled continually, and was too morose—
Was always behind hand, and tried to make bluff
Take place of ability—then get in a huff
If the boss called him down for what he deserved—
At the least opposition he'd get all unnerved.

He had no ideal, nor had he pluck—
Success he attributed to just plain luck.
Sometime he may wake up and then realize
That success can never be won as a prize;
He'll have to use energy, strength and will power,
And to make wisest use of each fleeting hour;
Stop dreaming—start doing—and then make his chance—
For that is the only sure way to advance.

Concord, N. H. C. H. WILLEY.

Put your oil holes in the center and not at the ends of your bearing. If they are already there plug them up and drill holes in the center.

Precaution Against Fire on a Diesel-Engined Ship

In a paper recently presented before the United States Naval Institute by Ensign Z. W. Wickes, U. S. N., describing the loss of the British motor vessel *Sebastian*, which was burned on May 8, 1917, while en route from New York to Rouen and Havre, France, with a cargo of petrolite, some valuable suggestions are made as to means for preventing such a fire on similar vessels.

The *Sebastian* was a tank motor vessel owned by Lane & MacAndrew, of London. The vessel was heavily laden and her only reserve buoyancy was located in the forward trimming tanks and ship's hold and in the engine room and after trimming tank. In the large engine room aft were located the propelling machinery, consisting of a Werkspoor Diesel engine, auxiliaries and two boilers, one above the other, for auxiliary use. Coal bunkers containing 50 tons of coal were located outboard of the boilers on both sides of the ship. Forward of the engine room was the main fuel oil tank, about 10 feet long, which occupied the full cross-section of the ship. Between the fuel oil tank and the after cargo hold was interposed a 4-foot cofferdam. There were located in the engine room two ready fuel oil tanks, holding about 5 tons of oil, which were filled daily. The overflow of these tanks was on the engine room floor plates, and no filling safety devices were installed. The engine room watch consisted of two engineers and an oiler.

The ready fuel oil tanks were being filled in the first dog watch, and by some undetermined cause overflowed. The oil spread over the engine room floor plates into the bilges and came in contact with the hot exhaust piping of the main engine. This ignited the oil, the flames spread rapidly and drove the watch out of the engine room immediately. The fire spread into the ready fuel oil tanks and the coal bunkers, the doors of which were open. The engineers' living quarters, which were located alongside the engine room hatch, were soon afire. The woodwork on the poop caught fire from there and the whole stern of the ship became very quickly a mass of flame. The intense heat of the burning oil and coal buckled the decks and sides of the ship and started the seams and rivets to such an extent as to allow water to pass into the engine room. The forward bulkhead of the engine room was affected in the same manner. As the fuel oil seeped through it caught fire, and the after side of the bulkhead became a sheet of flame.

The oil in the main fuel oil tank became dangerously heated, and several spontaneous combustions of the gas at the top of the tank took place on the afternoon of the second day. The covers of the two large hatches in the top of the tank, on the after well deck, were removed and sea water was pumped in by means of a handy-billy. After the oil had been somewhat cooled in this manner, the suction of the handy-billy was placed in the tank and the mixture of oil and salt water pumped overboard. More water was pumped in from time to time in an attempt to save the forward bulkhead of the engine room, which was becoming red hot. In this manner, after about twelve hours, the fire was extinguished. By the time the fire was put out, so that access could be had to the engine room, the ship was settling by the stern and heavy seas were breaking over the poop. The cargo was protected by the cofferdam, which was flooded by means of sea valves soon after the fire started.

The sketch of the course of the fire and brief outline of the location of the compartments in the after part of the ship led to proposed alterations in the design and equipment of the vessel which might prove of value in preventing a recurrence of such an accident on similar ships. The alterations are elementary and will require very little time or expense to make.

Undoubtedly the first and most important change must be made on the ready fuel oil tanks. A warning device to operate when the tank is 95 percent full and an automatic closing valve to close immediately afterwards could be installed in a very short time. These devices are already in use on larger tanks. The overflow pipe should be fitted, in case the above devices fail to operate. However, it should discharge in some place in plain view of the engineer on watch and where there would be no danger of the oil coming in contact with the hot piping.

The ship was not provided with any fire-fighting apparatus. It seems very pertinent that a vessel built to use heavy oil engines should be equipped with some form of a sand blast which could be operated from the upper gratings of the engine room. An oxygen helmet for use by the man operating the sand blast would be very valuable and necessary.

The two boilers for auxiliary purposes were situated on platforms, one above the other, in the after end of the engine room, as were the coal bunkers, so that all of the power on the ship was put out of commission by a fire in one compartment. The boilers should be placed in a compartment entirely separate from the engine room. No hand pumps were carried on the ship. Handy-billys, as supplied to the naval service, are very serviceable. Inasmuch as the engine room compartment was so large and formed practically all the reserve buoyancy aft, it would seem desirable to have a large power pump located in an accessible compartment, separate from the engine room and connected to the bilges of the latter.

In view of the construction of the ship and the location of the main fuel oil tank a cofferdam similar to the one between it and the after cargo hold could easily be placed betwen the tank and the engine room. Such a cofferdam would have protected the main fuel oil tank and the fire would have burned out in a few hours without the loss of the ship.

NEW BOOKS

Finding and Stopping Waste in Modern Boiler Rooms. By engineers of the Harrison Safety Boiler Works. Size, 9 by 7 inches. Pages, 276. Illustrations, 213. Philadelphia, 1918: Harrison Safety Boiler Works. Price, $1.

The saving of coal is the purpose of this practical handbook, which is addressed to power plant owners, managers, engineers and firemen. The statements, tables, charts, etc., have been selected as were supported by experiments and tests, references being given wherever possible to the original authorities.

Eye Hazards in Industrial Occupations. By Gordon L. Berry, Field Secretary National Committee for the Prevention of Blindness, with the co-operation of Lieutenant Thomas P. Bradshaw, U. S. Army, formerly technical assistant to the Director of the American Museum of Safety. Pages, 150. Numerous illustrations. New York, 1918: National Committee for the Prevention of Blindness, 130 East Twenty-second street. Price, 50 cents.

In this volume the author reviews the chief industrial hazards to eyesight in the industries of the United States. Case reports illustrate each section, the special dangers are described and recommendations made for such changes of working conditions, or installations of protective devices, as have been found suitable for protecting workers. The book is most completely illustrated.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number if from examination for grade of chief, and by a dagger (†) if from examination for other grades.

Strength of Solid and Bracket Floors

Q. (950).—Are there any published results of tests on floors made up of solid plates and bracket plates, showing the strength for different combinations of the same weight?

A. (950).—I know of no published results along the line indicated. It is generally accepted that the solid floor combination is preferable for merchant construction, as it is considered to give greater local strength for the same weight, and does not involve the costly construction work of the more continuous longitudinals. The system of complete continuous longitudinals as used in warships is, of course, obsolete for merchant vessels, and even for this system the so-called bracket floors are really solid floors with a central vertical strip cut out, as the earlier type of pure bracket construction has fallen into disfavor.

Horsepower of Engine

Q.* (942).—What is the horsepower of an engine 18 inches diameter of cylinder, 30 inches stroke of piston, 100 revolutions per minute, and 84 pounds mean effective pressure?

A. (942).—

$$I.H.P. = \frac{2PLaN}{33{,}000}$$

P = mean efficiency pressure, pounds per square inch,
L = length of stroke in feet,
a = area of piston in square inches,
N = number of revolutions per minute.

$$a = \frac{\pi \times 18^2}{4} = 254.5 \text{ square inches}$$

$$I.H.P. = \frac{2 \times 84 \times 2.5 \times 254.5 \times 100}{33{,}000}$$

$$= 324.$$

Twisting Moments on a Crank Shaft

Q. (949).—From page 123 of Reed's "Useful Hints to Sea-Going Engineers" (Fifth Edition), in mentioning some of the many problems that can be worked out from the indicator card diagram, there were included the curves of combined twisting moments on the crank shaft. Will you please explain what is meant by the twisting moments on a crank shaft, and which are these curves on the diagram?

A. (949).—By twisting moment on a crank shaft is meant the moment of the turning force applied at the center of the crank. If in turning a grindstone you exert at right angles to the crank a pull of 16 pounds and the crank is 9 inches or three-fourths of a foot long, you are exerting a twisting moment of $16 \times .75 = 12$ foot pounds on the grindstone shaft. Each cylinder, with its connecting rod and crank, exerts a twisting moment on *its* shaft which varies throughout the revolution. The curve of combined twisting moment is obtained by summing the twisting moments due to each crank taking account of the proper angular distance between it and the reference plane, and thus giving the resulting twisting moment on the shaft aft of the engine. This curve is obtained from the indicator diagram by measuring on it the steam pressures for various points in the stroke. These, multiplied by piston area, give the steam forces acting on the piston. These forces, when corrected for the effect of the reciprocating parts, are transformed into twisting moments and plotted on a separate sheet.

Calculating Evaporation of Water in Boiler

Q. (947).—From Reed's "Useful Hints to Sea-Going Engineers" (Fifth Edition), page 126, the following is taken:

"The following is a method for estimating the feed make-up required: Get the water well up in all the glasses, sufficiently high to last four or five hours without the extra feed being put on; keep the job running in its normal condition, with the steam on all the usual auxiliaries. After running the four hours, or as long as possible, note carefully how far the water has fallen in the glasses and also what the engines have indicated. Then if we take the breadth of the boiler at the average water level and the length, it is a simple matter of arithmetic to find the weight of water which has been lost. This, divided by the number of hours and the indicated horsepower, gives us the feed make-up required per hour per indicated horsepower.

(*a*) Will you please explain the simple matter of arithmetic referred to above, and (*b*) can one find out how much water has been evaporated from a boiler during a given length of time (say one hour) by this means?

A. (947).—(*a*) The method can best be explained by working through a specific case. Assume a Scotch boiler 16 feet 3 inches diameter and 11 feet 6 inches length, both dimensions taken to inside of shell, in which the water level is at the beginning of the run 4 feet down from the top of the boiler. At the end of three hours' running the water level is 4 feet 3 inches from the top of the boiler. The problem then is to find the areas of the two segments of circles, one of which has a height 12 feet 3 inches and the other a height of 12 feet. The difference between these is the net area of head uncovered which, multiplied by the length of the boiler, will give the entire contents lost. Areas of segments are most easily computed from tables issued in practically all handbooks using the table issued in Seaton & Rounthwaite's *Pocket Book of Marine Engineering*, 12th edition, page 547, the areas are:

Segment of 4 feet 3 inches height = 43.05 square feet
Segment of 4 feet 0 inches height = 39.60 square feet
Area of head uncovered = 3.45 square feet
Length = 11 feet 6 inches

Volume = $3.45 \times 11.5 = 39.7$ cubic feet = 297 gallons.

This has been lost in three hours, and assuming the indicated horsepower of the main engine to be 1,500, the makeup feed will be

$$\frac{297}{3 \times 1{,}500} = 0.0659 \text{ gallon per indicated horsepower per hour.}$$

Another though less accurate method, if the change of level is great, is to average the chords across the boiler head, multiply by the height the water has dropped and by the length of the boiler. For the case assumed, the chords

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* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

across the boiler face corresponding to the water levels at the beginning and end are 14 feet and 14.26 feet. The average is 14.13, the height the water has dropped is 3 inches or .25 feet, the volume is then $14.13 \times .25 \times 11.5 =$ 40.6 cubic feet, as against 39.7 cubic feet obtained by the first method.

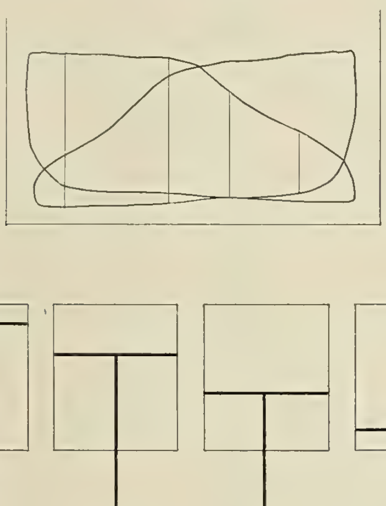
(*b*) No, you cannot find by this procedure the amount of water evaporated from the boiler unless you entirely stop the feed to the boiler during the whole period.

Pressure on Crank Pin and Rotative Effect

Q. (948).—From Reed's "Useful Hints to Sea-Going Engineers," pages 161 and 162, with reference to the influence exercised by the connecting rod over the distribution of pressure on the crank pin, it says as follows: "The advanced study of the indicator card is too much neglected, and the majority of those in charge of engines are very apt to acquire an idea that the indicator card as they see it fresh from the cylinder is a perfect record of the pressure of the steam on the piston, and therefore on the crank pin. A greater mistake than this never existed, because it is quite likely that in a moderately heavy engine of quick piston speed, the greatest pressure on the pin is nearly at the exhausting end of the stroke, especially towards the end of the up-stroke. To such an extent does the connecting rod influence the distribution of pressure, that it is quite safe to assert that if the pressure on the guide does not prove excessive, in a heavy, very quick-running engine, a connecting rod of two and a half or three cranks would give more equal pressure on the crank pin than one of four or five cranks in length. It must be borne carefully in mind that the above refers only to pressure on the pin, not to rotative effort, which to be equal throughout the stroke, requires a heavy pressure, gradually getting lighter and again increasing towards the other end of the stroke. (To illustrate the different effects, an indicator card has been taken to which has been applied the necessary alterations caused by the inertia of the parts, the angularity of the connecting rod, and the gravitation effect of the moving parts, in which card the pressure on the crank pin at each ten degrees travel of the crank are such that when each is multiplied by its leverage, the resulting rotative effort is, excepting for the first and last few degrees, practically uniform for the up-stroke.)"

The above is a little too brief. Will you please illustrate how the connecting rod influences the distribution of pressure on the crank pin; also explain how the different pressures, when multiplied by these leverages, give a resulting rotative effort?

A. (948).—The author apparently means by the "pressure on the pin" that due to the force acting along the connecting rod, but has not clearly differentiated between



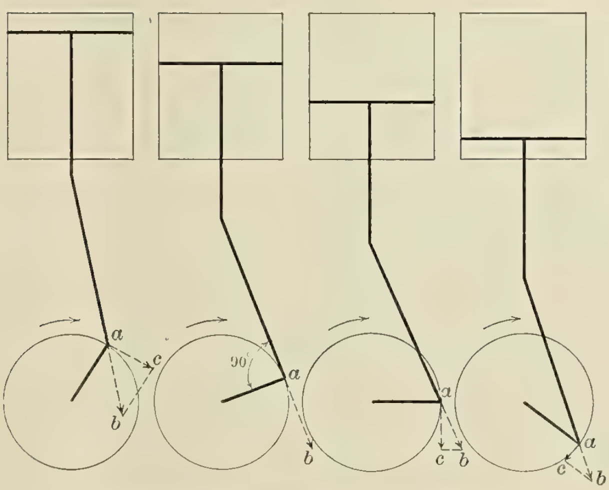


Diagram of Forces on Crank Pin

the part of it due to the steam forces and the part due to the weight and inertia of the reciprocating parts.

For the moment consider only the steam forces which are correctly determined directly from the indicator diagrams by measuring the pressures on the top and bottom of the piston and taking the difference or by measuring the ordinates of the cards, as shown on the figure between the admission and expansion line of one diagram and the exhaust and compression line of the other diagram. These pressures, when multiplied by the area of the piston, give the actual steam forces acting on the piston, and are forces acting in the line of centers. These forces produce forces along the rod which are shown in the diagram for several positions of the piston and connecting rod. This force along the rod is lettered *a-b* in each case. Now, as noted in the previous question, the force which does the useful work of turning the crank is that at right angles to it, so if we break up the force along the rod into its components at right angles to the crank (*ac*) and along the crank (*cb*) the useful force (*ac*) can be found, and this force is the "rotative effect" (uncorrected).

The figure clearly shows that this is a different percentage of the force along the rod dependent upon the angle between the rod and the crank, and is only equal to the force along the rod when, as in the second case, the angle is 90 degrees.

In the figure the force along the rod has been taken as that due to the steam force only, actually owing to the effect of the weight and inertia of the reciprocating parts this is modified, but after its corrections have been added or subtracted, the resulting or true force along the rod is analyzed just as outlined above.

Measuring Angular Advance of Eccentric

Q. (937).—How would you measure the angular advance of an eccentric?

A. (937).—Jack the engine over till the eccentric rod is on its dead center and scratch a line on both the eccentric sheave and strap, then continue jacking the engine till the crank for the same cylinder is on its dead center. The divergence between the scratches on the eccentric and its strap converted into degrees will be the angular advance. The conversion of the measurement along the circumference of the eccentric into degrees of angular advance is probably done most readily by laying it out to scale and measuring the angle as shown. The analytical solution, however, presents no difficulties and is, of course, more accurate. A solution is appended for an assumed case:

Assumptions

Diameter of shaft = 15 inches.
Eccentricity = 3 inches.
Diameter of eccentric sheave = 21 inches.
Divergence of cuts, measured on circumference of eccentric sheave = 7 inches.

Solution

$$\text{Angle } ACB = \frac{7}{\pi D} = 38^\circ\ 18',$$

$$\text{Angle } ACB = 180^\circ - (38^\circ\ 18'),$$
$$= 141^\circ\ 42',$$

$$\frac{BC + CD}{BC - CD} = \frac{\tan \tfrac{1}{2}(CDB + DBC)}{\tan \tfrac{1}{2}(CDB - DBC)},$$

$$\frac{13.5}{7.5} = \frac{\tan \tfrac{1}{2}(38^\circ\ 18')}{\tan \tfrac{1}{2}(CDB - DBC)},$$

Therefore, $CDB - DBC = 23^\circ\ 4'$,
$CDB + DBC = 38^\circ\ 18'$.

$$\text{Angular advance} = CBD = \frac{61^\circ\ 22'}{2}$$
$$= 30^\circ\ 4'.$$

Shipbuilding and General Marine News

**Contracts for New Ships—Shipyard Improvements—
Engineering Projects—Improved Appliances—Personal Items**

HOG ISLAND PLANT UNDER INVESTIGATION

Attorney-General to Investigate Operations of American International Shipbuilding Corporation

Contract with the U. S. Shipping Board Emergency Fleet Corporation May Be Canceled

Disclosures by the Senate Commerce Committee, indicating waste and extravagance in the operations of the American International Corporation, which, though a subsidiary, is constructing the Hog Island shipyard, and has the contract for building 120 vessels at this yard, have led President Wilson to instruct the Attorney-General to thoroughly investigate the operations of the company building this plant.

Complaints

The complaints against the American International Shipbuilding Corporation are based principally on the following disclosures:

The Government was compelled to pay for the site at Hog Island from $2,000 to $2,500 per acre, whereas a large part of the island had been optioned at $1,000 per acre for a long period immediately prior to its acquisition by the Shipping Board.

The fee of approximately $7,000,000 which the contractors are to receive as their remuneration for organizing and carrying out this work is considered excessive.

Salaries paid to many of the employees are considered excessive, a case in point being a so-called publicity department, the chief of which is paid at the rate of $10,000 a year, while several assistants receive from $6,000 to $7,500 each.

Unnecessary delays and confusion in carrying out the work, due to faulty planning.

Excessive labor expenditures.

"Graft" Denied

In explanation of these alleged conditions, the officials of the American International Corporation deny the existence of any so-called graft in the operations of the company. Although in many cases expenditures have greatly exceeded the estimates originally made, nevertheless it is held that the final results will show that neither the corporation itself nor any of its sub-contractors will make large profits or commissions from the project. On the other hand, the profits will be abnormally small as compared with similar work in civil life.

Officials of the American International Corporation do not hesitate to admit that mistakes have been made, but state that in view of the necessity for haste and explicit orders from the Shipping Board to speed up all operations rather than give first consideration to economy, the results will be justified.

Fifty Shipways to Be Built

As a matter of fact, it is now planned to construct the entire fifty shipways originally planned for the yard, and, according to reports from Rear-Admiral F. T. Bowles, who is now supervising the work at the yard for the Emergency Fleet Corporation, the last of the fifty keels will be laid about May 17, if the weather is not too severe.

The contract of the American International Shipbuilding Corporation calls for the delivery of fifty ships by November 1, 1918, and, according to present indications, it seems likely that the ships will be built on schedule. The total contracts now held by the American International Shipbuilding Corporation call for 120 vessels, 50 of which are to be 400 feet long and 7,500 tons deadweight carrying capacity, and 70 vessels 450 feet long of 8,000 tons deadweight.

British Shipbuilding in 1917

According to figures given by Andrew Bonar Law, Chancellor of the Exchequer, in a speech before the House of Commons, British shipyards in 1917 turned out 1,163,474 tons of merchant vessels. In addition to this output, 170,000 tons were purchased from abroad.

During the same year, American shipyards built 901,223 tons of merchant vessels, making a total combined British and American tonnage of 2,064,697 tons, against which some 6,000,000 tons of shipping has been destroyed by the German U-boat warfare.

Shipping Comptroller for New York Appointed

H. H. Raymond, president of the Clyde and Mallory Steamship Lines, was named on January 28 by Chairman E. N. Hurley, of the Shipping Board, comptroller of shipping at the port of New York, with full power to direct the operation of the Board. Mr. Raymond has taken active charge of the affairs of the Division of Operations at New York.

Chief Machinist's Mates Commended for Heroism

Niels Anderson, chief machinist's mate, United States Navy, and Walter D. McLea, chief machinist's mate, National Naval Volunteers, have been commended by the Secretary of the Navy for their heroism on December 17, 1917, when the exhaust lines of the steering engine on the vessel on which they were stationed were carried away by the breaking of the tiller, causing the engine-room to fill with live steam. After three attempts, both of these officers succeeded in entering the steam-filled room and turning off the steam.

WATER TRANSPORTATION INQUIRY

American Coastwise and Inland Waterway Tonnage Decreases

According to a preliminary report just issued by Director Sam. L. Rogers, of the Bureau of the Census, Department of Commerce, and compiled under the supervision of Mr. Eugene F. Hartley, chief statistician in charge of the recent water-transportation inquiry, made as of December 31, 1916, American-owned merchant vessels of five tons net register or over, of all classes, operating during the year 1916 on the coast or inland waters of the United States, including Alaska, or between ports of the United States and foreign countries, numbered 37,894, and had a total gross tonnage of 12,250,000.

The geographical distribution of this gross tonnage was as follows: Atlantic Coast and Gulf of Mexico, 6,509,000; Mississippi River and its tributaries, 1,621,000; Pacific Coast, including Alaska, 1,186,000; Great Lakes and Saint Lawrence River, 2,738,000; canals and other inland waters, 196,000. The distribution, according to methods of propulsion, was: Steam and other power, 6,098,000; sail, 1,089,000; unrigged, 5,063,000.

Decrease in Tonnage Since 1906

The increase in number of vessels as compared with 1906 was equal to only 1½ percent, and the gross tonnage shows a decrease amounting to 5 percent. This is accounted for by the marked falling off in number and tonnage of sailing vessels and in tonnage of unrigged craft. The former show a decrease in number from 7,131 to 2,979, or 58 percent, and in gross tonnage from 1,704,000 to 1,089,000, or 36 percent. Unrigged craft, although increasing slightly in number, from 20,263 to 20,334, or four-tenths of 1 percent, show a decrease in tonnage from 7,130,000 to 5,063,000, or 29 percent. On the other hand, craft propelled by steam and other power increased in number from 9,927 to 14,581, or 47 percent, and in tonnage from 4,060,000 to 6,098,000, or 50 percent.

The average tonnage per vessel, for the country as a whole, decreased from 345 in 1906 to 323 in 1916.

The proportional increase during the 10-year period in number of vessels was most pronounced on the Pacific Coast, including Alaska where it amounted to 61 percent; but the greatest rate of increase in tonnage, 34 percent, appears for the Atlantic Coast and the Gulf of Mexico, as against 21 percent for the Pacific Coast, including Alaska. For the Great Lakes and St. Lawrence River the increase in tonnage was 14 percent. On

the other hand, a great decrease in tonnage, from 4,412,000 to 1,621,000, or 63 percent, took place on the Mississippi River and its tributaries; and a decrease of 24 percent appears for canals and other inland waters.

INCREASES IN VALUE AND BUSINESS DONE

Despite the very small increase in number of vessels and the falling off in total gross tonnage throughout the country as a whole during the ten-year period the figures for value of vessels, gross income, wages paid, and freight carried show marked increases, amounting to 89 percent, 91 percent, 44 percent, and 42 percent, respectively. The number of employes, however, increased by less than 9 percent, and the number of passengers carried shows a decrease of not quite 10 percent. The foregoing items, for the year 1916, are, in round numbers, as follows: Value of vessels, $960,000,000; gross income, $564,000,000; wages paid, $103,000,000; freight carried, including lighterage, or harbor work, 376,000,000 tons of 2,000 pounds; number of employes, 153,000; number of passengers carried, 331,600,000.

The pronounced increase between 1906 and 1916 in freight carried, accompanied as it was by a falling off in gross tonnage, is accounted for by the fact, already pointed out, that the decline in tonnage took place entirely in sail and unrigged craft and was offset in considerable part by a decided increase in tonnage of steam and other mechanically propelled vessels, which, because of their greater speed, are able to carry more freight per annum, in proportion to tonnage, than can be transported by other classes of craft.

The decrease in the number of passengers carried is due to the reduction in ferry traffic resulting from the establishment of the "tube" service in Greater New York.

The vessels operating on the Atlantic Coast and the Gulf of Mexico represented somewhat less than three-fifths of the total number for the United States, a little more than half the total gross tonnage, and about two-thirds the total value, and reported nearly half the total freight carried. The percentages of increase in gross tonnage, value, gross income, and wages paid—34, 130, 136, and 54, respectively—were much greater for these vessels than the corresponding percentages for those operating in other sections of the country. In respect of freight carried, however, the increase for the Atlantic Coast and the Gulf of Mexico was relatively small, being only 29 percent, as against 44 percent for the Mississippi River and its tributaries, 43 percent for the Pacific Coast, including Alaska, and 67 percent for the Great Lakes and St. Lawrence River. Canals and other inland waters, however, show a decrease of 22 percent.

IDLE VESSELS

The figures above given relate to vessels which were in active operation during all or a part of the year 1916. In addition, the report for 1916 shows 2,681 vessels, with a gross tonnage of 363,000, or less than 3 percent of the total tonnage, as idle during the entire year. The increases in number and tonnage of idle vessels during the 10-year period amounted to 52 percent and 103 percent, respectively. These increases appear for both power and unrigged craft, but a decrease from 565 to 307 is shown for idle sailing vessels, although the tonnage of such vessels increased from 20,000 to 30,600. The proportion which idle tonnage represented of the total shows an increase from 1906 to 1916 for each of the three classes of craft.

Institution of Naval Architects to Hold Annual Meeting

The annual meeting of the Institution of Naval Architects will be held in the hall of the Royal Society of Arts, John street, Adelphi, London, W. C., on March 20 and 21, with the Right Honorable the Earl of Durham, K. G., G. C. V. O., P. S., president, in the chair.

A gold medal will be awarded by the Council to any person, being a member or associate member of the council, who shall at the forthcoming meeting read a paper which, in the judgment of the Council, is deemed to be of exceptional merit. The Council will also offer a premium of books or instruments to the reader of any paper, not being a member or associate member of the Council, which, in the judgment of the Council, merits this distinction.

CONTRACTS FOR NEW SHIPS

The United States Shipping Board, Washington, D. C., has placed contracts during the past few days for 46 steel steamships. It is reported that these ships are all of 10,000 tons each, and that they will cost about $115,000,000.

Horton & Horton, Houston, Tex., have received contracts from the United States Shipping Board to build six 3,000-ton wooden ships.

The Peninsula Shipbuilding Company, Portland, Ore., H. H. Fisher, purchasing agent, has received contracts from the Shipping Board to build eight steamships.

The Coast Shipbuilding Company, Portland, Ore., will make a large addition to its plant. This company has received a contract from the Shipping Board to build ten steamships.

The Chilman Shipbuilding Company, Hoquiam, Wash., has received a contract to build two auxiliary schooners for a French Company.

The Toledo Shipbuilding Company, Toledo, O., A. D. Black, purchasing agent, has a contract from the U. S. Shipping Board to build eight ocean-going steel steamships.

The Albina Engine & Machine Works, Portland, Ore., W. L. Deute, purchasing agent, has a contract from the U. S. Shipping Board to build four steamships.

The Atlantic Corporation, Portsmouth, N. H., which has a contract from the U. S. Shipping Board to build ten steamships, is enlarging its plant, and, according to report, will spend $1,000,000 for new equipment.

The United States Steamship Company, 50 Broad street, New York, which owns the plant of the Groton Iron Works at Groton and Noank, Conn., has organized the Virginia Shipbuilding Company, Alexandria, Va. This latter company has a contract to build twelve steel steamships for the United States Shipping Board.

The Ferro Concrete Shipbuilding Corporation, Redondo Beach, Cal., is reported to have received a contract from the U. S. Shipping Board to build ten 3,500-ton concrete ships.

The Spedden Shipbuilding Company, Baltimore, Md., A. W. Gieske, president, is building a 135-foot steel tug.

The Portland Company, Portland, Me., has received a contract to build a wooden freight steamship for the Great Northern Paper Company.

NEW SHIPYARDS PLANNED

Companies Organized Within the Month for Building Ships

Additions and Improvements to Shipyards in Operation

The Rangeley-Hanson Company, Brooklyn, N. Y., according to report, will build a shipyard at Bay 35th street and Cropsey avenue, Brooklyn. It is reported that the company has contracts to build a number of government vessels. J. S. Glaser is president of the new concern.

The West Harbor Shipbuilding Company is reported to have made plans to build a wooden shipbuilding plant at Boothbay Harbor, Maine.

The Merchant Shipbuilding Corporation, with yards at Bristol, Pa., whose purchasing agent is E. L. Fries, Finance Building, Philadelphia, is planning to build ten new shipways and, in addition, plate shop, machine shop, etc.

The Margaret Ship Company has been incorporated by E. Wrack, J E. Downes and others, 17 Battery Place, New York.

The Seattle Ship and Construction Company, Seattle, Wash., which has recently been organized, has acquired a site on Lake Washington, where it will build a shipyard.

It is reported that W. H. Gahagan, Rockaway Ave., Brooklyn, N. Y., will build a shipyard at Arverne, L. I., on Jamaica Bay. He is reported to have received a contract to build thirty barges for the U. S. Shipping Board.

Operations are well advanced on the new shipbuilding plant of the Groton Iron Works, near New London, Conn. The ships to be built at this plant will be of the standardized 8,800-ton type.

The Rayburn Lumber Company, Kansas City, Mo., and Apalachicola, Fla., is planning to build a shipyard at Apalachicola.

The Pensacola Marine Construction Company has been organized at Pensacola, Fla. F. W. Blount is president and treasurer.

The Bruce Dry Dock Company, Thomas A. Johnson, purchasing agent, Pensacola, Fla., is planning to build another sectional dry dock and a floating dry dock.

The Acme Scow Corporation, Roslyn, L. I., has been incorporated by P. J. Dobson, J. A. Morden and J. V. A. McCloskey, 64 Wall street, New York, to build a boat works.

The Astoria Boat Works and Marine Equipment Company, 561 Boulevard, Long Island City, N. Y., will enlarge its plant.

Cornelius A. Coe, Hackensack, N. J., and associates, have organized the Ferro Concrete Shipbuilding Company, with a capital stock of $10,000,000.

The Universal Shipbuilding Company, Sturgeon Bay, Wis., has been organized

to take over the plant of Rieboldt, Wolter & Company, Sturgeon Bay. The general manager of the new company is Gustav A. Huck.

It is reported that Norwegian Vice-Consul Belland, Seattle, Wash., with several other Norwegians, plans the establishment of a shipbuilding yard and dry dock at Seattle.

E. J. Adams, Eugene, Ore., is at the head of the syndicate that plans the construction of a shipbuilding plant at Florence, Ore.

Construction work has been started at the plant of the Oceanic Shipbuilding Company, Milwaukee, Ore. This yard will have the capacity to build ten government ships yearly.

Work will be started immediately on the $1,500,000 steel shipbuilding plant to be erected in Vancouver, Wash., by the G. M. Standifer Construction Corporation, J. J. Burke, general manager, Vancouver, Wash.

The Portland Shipbuilding Company, Portland, Ore., has acquired 650 feet of frontage on the Columbia River, where it will build a new plant.

The Williams Shipbuilding Corporation, R. M. Williams, president, Tampa, Fla., has acquired a site of land at Tampa and will build a yard for the construction of steel vessels.

The offices of the purchasing department of the Sun Shipbuilding Company, formerly located at 1428 So. Penn. Square, Philadelphia, Pa., have been removed to Chester, Pa.

The Pensacola Shipbuilding Company, 155 N. Clark street, Chicago, Ill., writes MARINE ENGINEERING, asking that catalogues of firms manufacturing shipbuilding and shipyard machinery be forwarded to them as soon as possible.

One Hundred and Sixty-First Vessel Launched at Davis Shipyard

Early in January of this year the Davis shipyard at Solomons, Md., launched their one hundred and sixty-first vessel, a 1,700-ton coal barge for the Northern Transportation Company. Before the end of the month they had launched another vessel building for the Bethlehem Steel Corporation. This was a tug boat, 133 feet long, equipped with a 1,000-horse power engine.

The Davis shipyard has six building ways and makes a specialty of tugs and barges.

Fig. 2.—View of Davis Shipyard at Solomons, Md., from Waterfront

Fig. 1.—Bow View of Tug for Bethlehem Steel Corporation and Two Barges for Northern Transportation Company under Construction at the Davis Shipyard, Solomons, Md.

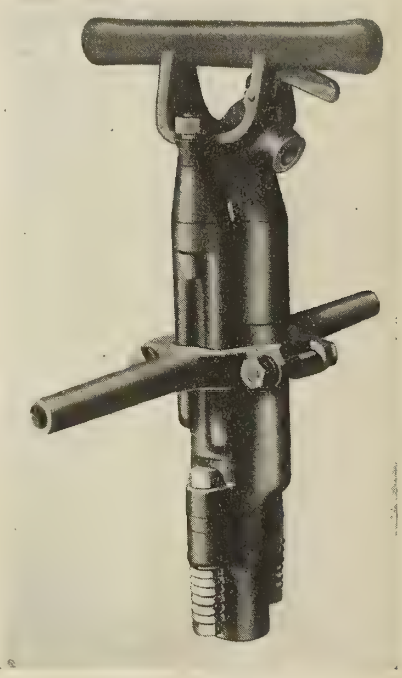
Transatlantic Shipping Under Centralized Control

By the creation of a Ship Control Committee, to have supreme charge of the operation of all ships, American, allied and neutral, entering and leaving American ports, the control of transatlantic shipping has been placed under one head. The Ship Control Committee is composed of P. A. S. Franklin, president of the International Mercantile Marine, chairman; H. H. Raymond, recently appointed comptroller of shipping of New York, and Sir Cunnop Guthrie, who will represent Great Britain, France and Italy.

The arrangement creates a pool of ships moving supplies to Europe. Goods destined for overseas will be loaded in available ships, whether operated by the United States or the Allies. By giving this committee absolute power in the allocation of all tonnage on both sides of the Atlantic, it is believed that the complications and delays which have occurred in handling the United States and allied shipping will be eliminated, and that the efficiency of overseas transportation will be greatly increased.

New Drift Bolt Driver

For driving drift-bolts in ship construction, dock building and similar work, the Ingersoll-Rand Company, New York, has developed and is placing on the market the very powerful pneumatic hammer illustrated. This has been designated Ingersoll-Rand No. CC-25.



Pneumatic Drift Bolt Driver

The machine is of substantial through-bolted construction, has a renewable hammer block bushing and a spring retained front-head to absorb shock. That the machine is built to withstand severe service is evident from the manufacturers' statement that the cylinder, front-head, hammer block, bearing, piston, cylinder cover, bolts and throttle lever are drop forged from special steels and that all wearing parts are given special heat treatments.

The over-all length of the I-R Drift Bolt Driver is 25 inches, its weight 65 pounds. It will drive drift-bolts up to 1½ inches diameter and of 10 foot length. It is normally handled by two men, a second handle being clamped to the center of the tool. An inside trigger controls the operation of the machine and it has been demonstrated that a

light or heavy blow can be obtained at the will of the operator.

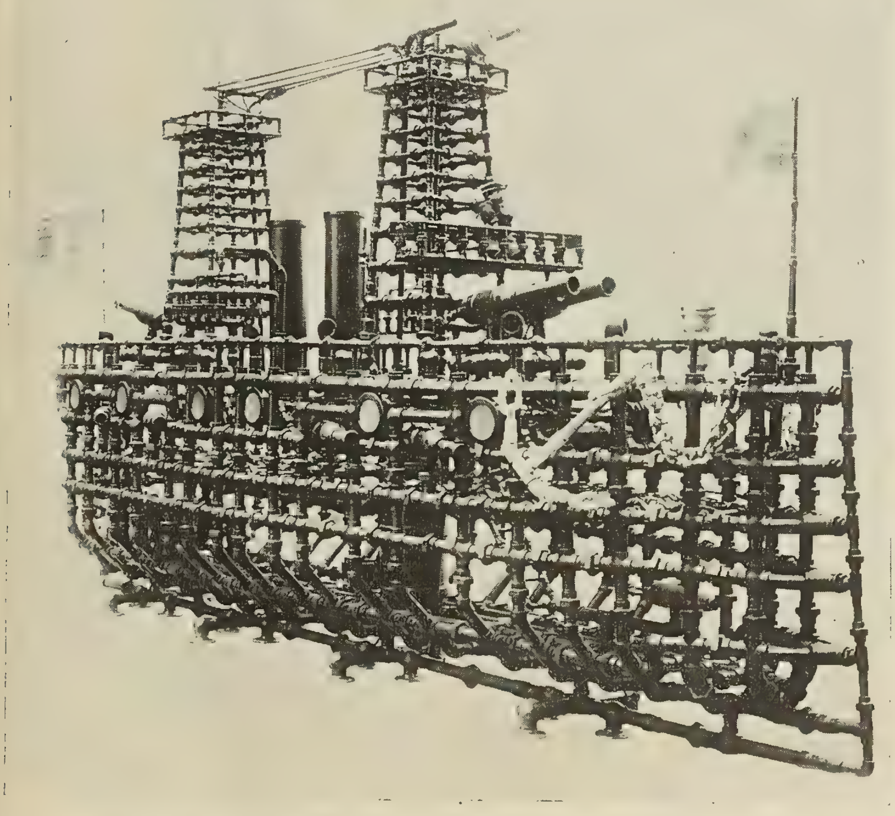
Doctor Eaton Heads National Service Section on Shipping Board

Dr. Charles A. Eaton, D.D., pastor of the Madison Avenue Baptist Church, New York city, has been appointed head of the National Service Section of the United States Shipping Board Emergency Fleet Corporation. With a staff of assistants, Dr. Eaton will visit the shipyards throughout the country for the purpose of arousing the patriotism and loyalty of shipyard workers and developing widespread adoption of thrift and industry among the shipbuilders and their families.

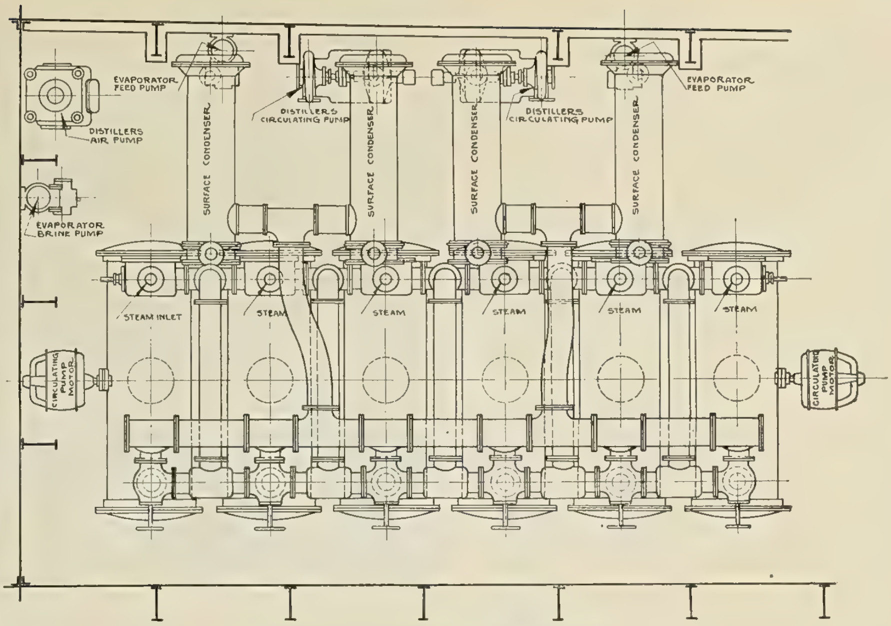
Model of U. S. S. New York Made of Crane Company Products

An employee of the Crane Company (Chicago) in the works of the company's Bridgeport division has made an ingenious model of the superdreadnaught *New York*, from Crane Company products—fittings, valves, specialties, etc. The over-all dimensions of the model are: Length, 186 inches; breadth, 34 inches; molded depth, 42 inches; total height from keel to top-mast, 102 inches. Its net weight is 3,308 pounds.

Six thousand six hundred and sixty-nine separate pieces enter into the construction of this model. It is complete to the smallest detail, and the ordinary working parts of a battleship are movable. A row of colored electric lights run from bow to stern over the mast tops, and, when in action, the model makes an interesting exhibition.



Crane Fittings Joined Together to Form Model of U. S. S. *New York*



New Modification of Lillie Evaporator

Unusual Design for Distilling Sea Water

Those who have to deal with the distilling of sea or other water, or with evaporation problems of almost any kind, will be interested in this design of Lillie Evaporator now being built by the Wheeler Condenser and Engineering Company, of Carteret, N. J. It is a modification of a regular Lillie sextuple effect sea water distilling apparatus. Two of these now under construction are to be operated by steam up to 60 pounds per square inch gage pressure, or at any lower pressure.

The point that will catch the veteran's eye is the employment of four condensers, side by side, as distinctly shown in the illustration.

This unusual arrangement of condensers permits seven different combinations of operation, as follows:

(1) It may be operated as one single effect or more single effects;

(2) It may be operated as one or more double effects, with vapors reversible in each;

(3) It is possible to operate it as a triple effect, or as two triple effects, with vapors reversible in each;

(4) It is impossible, of course, to operate it as two quadruple effects, but every effect may be utilized by grouping as one quadruple effect and one double effect, in both of which the vapors are reversible;

(5) It may be operated as one vapor reversible quadruple effect, with both end effects or either end pair of the section cut out;

(6) With one effect at either end cut out, it may be operated as a vapor reversible quintuple effect;

(7) Lastly, it may be operated as a vapor reversible sextuple effect.

It is evident that should a mishap occur at either end, in the middle, or anywhere else, there is little danger that this evaporator will be put out of commission entirely.

Concrete Ships to Be a Part of Government Shipbuilding Program

Plans and specifications for a standard type of reinforced concrete ship, of approximately 3,500 tons deadweight cargo-carrying capacity, are being made by the Department of Concrete Ship Construction of the Shipping Board. Contracts for several reinforced concrete vessels have already been let, the first to the Liberty Shipbuilding Company, Boston, and two others to the Fougner American Steel Concrete Shipbuilding Company, New York, and the Ferro Concrete Shipbuilding Corporation, New York. The number of ships called for in these contracts is dependent upon the success attained in the first vessels built.

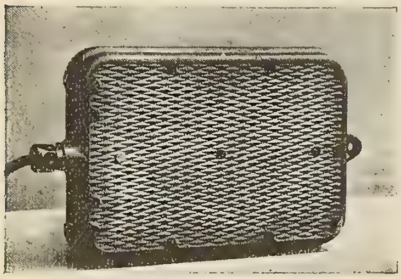
The present program of the Board, involving five vessels of different designs are essentially an experiment and upon their success or failure will depend the future of the Government's concrete ship construction. The Department of Concrete Ship Construction is also conducting a number of tests under the direction of the Bureau of Standards and the Shipping Board is co-operating with the United States Steamship Inspection Service and Lloyd's Register of Shipping. It is expected that the question of concrete barges for harbor and inland waterway service will be taken up by the various governmental bureaus concerned with that work.

The Department of Concrete Ship Construction is under the direction of James O. Hayworth, head of the Division of Wooden Shipbuilding of the United States Shipping Board Emergency Fleet Corporation, with Rudolph J. Wig, of the United States Bureau of Standards, as chief engineer. Lewis J. Ferguson is assistant chief engineer, Robert W. Boyd, of New York, consulting concrete engineer, and W. A. Slater, of the University of Illinois, concrete engineer.

The preliminary work of this department is being rushed so that definite results will be at hand early in the summer. If the experimental work proves satisfactory there will then be an opportunity for quantity production of concrete vessels during the summer.

No More Cold Feet for Ship Lookouts or Shipyard Watchmen

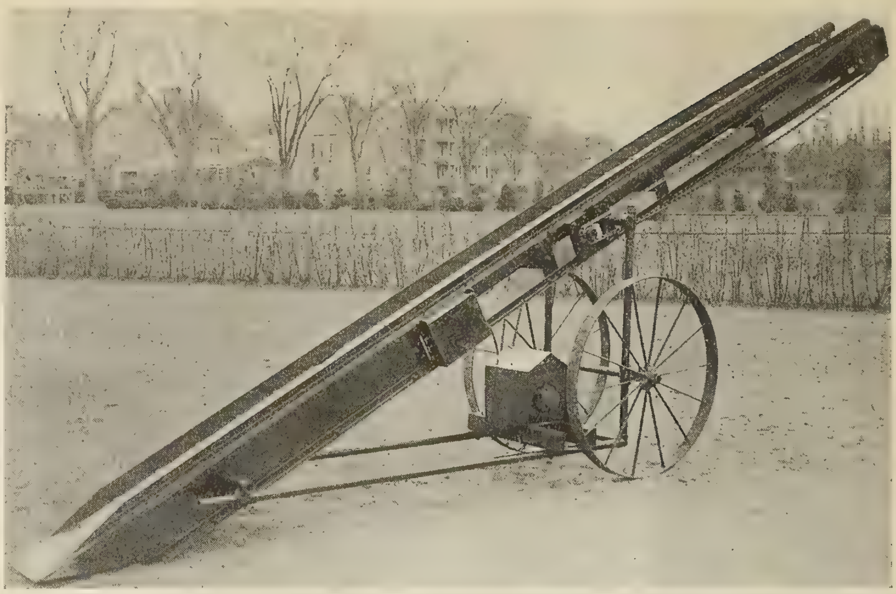
To minimize the discomfort of long standing outdoors in severe weather, an electrically heated foot-warmer has just been placed upon the market by the Westinghouse Electric and Manufacturing Company, of East Pittsburg, Pa. While designed primarily for lookouts



Electric Foot Warmer

stationed in the bow and crow's-nest of vessels, the device is applicable to the use of watchmen, sentries, doormen, traffic policemen and others whose work requires them to be out of doors continuously, with little chance for exercise. It has been found that if the rest of the body is adequately clothed, a footwarmer will ensure comfort at any temperature.

The device consists of a casting 14 inches by 20 inches by 25 inches, with diamond-tread top. This is of cast iron, or of aluminum where non-magnetic qualities are desired, as in ship service. Against the under surface of this the heater element is clamped. The heater is a slotted ribbon clamped between two plates of built-up mica, so arranged as to give uniform distribution of heat. A sheet-steel plate, fastened by screws and sealed with high-melting gum, renders the entire unit waterproof. The resistance is divided into two parts, which may be connected to draw 200, 100 or 50 watts at 125 volts. A three-conductor cable seven feet long is provided. By using the lower heats in mild weather, there is no danger of causing chilblains.



Portable Belt Conveyor, Which Scoops Up Material to Be Conveyed

Portable Scoop Conveyor

A new type of portable belt conveyor, operated by electric motor or gasoline (petrol) engine, is being manufactured by the Portable Machinery Company, Inc., of Passaic, N. J. The machine is known as a scoop conveyor, because the conveying belt receives its material through a scoop which can be pushed or completely buried into the material to be conveyed.

The object of the scoop conveyor is to provide a portable machine that can be readily handled by one man for the purpose of loading and unloading and stacking and reclaiming loose materials, such as coal, coke, ashes, crushed stone, sand, gravel, etc. The manufacturers claim that it will also handle sacks, packages, boxes and various manufactured products, and that one man and the scoop conveyor will handle loose materials at the rate of one ton in one and one-half minutes.

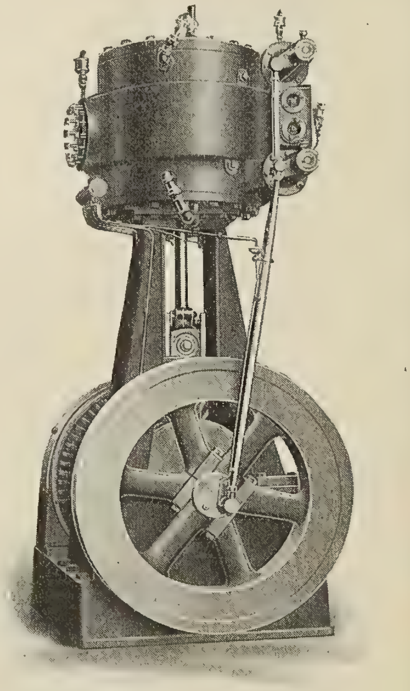
Keeping cars and trucks moving and cutting cost of hand shoveling is a necessity under present-day operating conditions, and a large number of well-known manufacturing concerns are already using anywhere from one to ten of these machines for this purpose.

Wheeler Vertical Rotative Dry Vacuum Pump

This vertical type of dry vacuum pump manufactured by the Wheeler Condenser and Engineering Company of Carteret, N. J., is in demand by ship and stationary plant builders who are anxious to save as much space as possible, and who at the same time have their eyes open to economy.

The pump shown was recently shipped by the manufacturers for installation in an American navy vessel. Another is in course of completion and will soon be shipped.

Where much condensing is to be done and where high vacuum is to be maintained, it is generally best to install separate condensate and air pumps. Thus a motor or turbine-driven centrifugal hot well pump can easily take care of the condensate while this Wheeler dry vacuum air pump withdraws the air.



Wheeler Vertical Dry Vacuum Pump

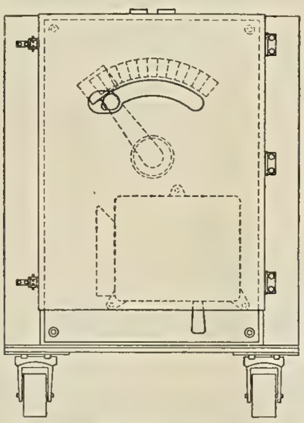
As the photograph distinctly shows, the inlet valves of this pump are of the semi-rotative type, which are so manipulated by the valve gear as to draw air from the condenser during its full stroke. Clearance difficulties are eliminated in this design of valve gear by providing ports which register with an

equalizing passage. The discharge valves are of the poppet type and are easily accessible. In fact, all parts are easily accessible, a point that is of great value in high-vacuum pumping machinery. Valve arrangement is such as to insure perfect drainage at all times.

A motor-driven dry vacuum pump has numerous other advantages over direct steam drive, among which are: ease of installation, less attention is required, no steam pipe radiation losses, and improvement of plant load factor. A few years ago it was argued that motor drive was poor practice because of the long train of elements through which power must pass before reaching the motor—the engine, generator, transmission lines, switchboard, etc.—but to-day shut-down troubles have practically vanished and authorities are strongly recommending motor-driven auxiliaries such as this dry vacuum pump.

Portable Outlet Panels for Electric Welding Service

For an electric welding outfit to be of its maximum service, it must be so arranged that it can be taken to the work, no matter where that may be located. One solution of the problem would, of course, be to locate a panel outlet of a suitable type wherever it is anticipated that electric welding might be desired. However, this is rather an



Portable Outlet Panel to Control Current for Electric Welding

expensive proposition, and many electrical engineers would prefer to accomplish the same result in a simpler manner. A recently developed portable outlet panel manufactured by the Westinghouse Electric and Manufacturing Company, East Pittsburg, Pa., takes care of this situation with a minimum of expense and with all the simplicity of the familiar distributing system for storage battery charging.

Two types of portable outlet panels are furnished, both being mounted on light trucks. They consist of a control panel mounting a handle trip railway type circuit breaker having overload release with magnetic blowout, and a 13-point face plate connected to a resistor mounted in the rear of the panel. The face of the panel is protected by a metal cover through which the handles of the rheostat and circuit-breaker project. The resistor is made up of grids and is protected by a cage of expanded metal. Type E panel is intended for metal electrode welding, only having a capacity of from 80 to 170 amperes. With this outfit one metal electrode holder and one shield are supplied. For a wider range of work a Type F panel should be used. This will handle metal electrode work from 80 to 160 amperes, and light graphite electrode work up to 300 amperes. The outfit includes one metal electrode holder, one graphite electrode holder and one mask.

Marine Terminal Improvements

The Port Authorities of Adelaide, N. S. W., Australia, are planning to build four 1,000-foot piers, in addition to making further improvements.

The British Dominions Royal Commission, London, England, is planning vast improvements at South African ports. It is planned to spend over $13,000,000 at Durban and $15,000,000 at Capetown. Less extensive improvements are planned for other African ports.

The Oregon-Washington Railway & Navigation Company, S. Murray, Portland, Ore., chief engineer, has drawn plans for a $200,000 wharf at the foot of Hanford street.

The Board of Public Works, Beaumont, Tex., will receive bids for building several large wharves.

The State Board of Harbor Commissioners, San Francisco, Cal., will soon receive bids for building a 108 by 200 foot addition to pier 21.

The Dominion Coal Company, St. John, N. B., has let the contract to rebuild Robertson's Upper Wharf to D. C. Clark, West St. John ,

New Naval Patrol Boats to Be Built in Record Time at Ford Automobile Factory

A new type of naval patrol boat, said to possess many of the advantages of the regular destroyers, but of smaller size, has been designed by the Navy Department in the short interval of ten days, and a contract for the construction of a large number of these vessels was given to Henry Ford, the automobile builder of Detroit, on January 17. Twenty days later the keel of the first of these boats was laid, and construction of the fleet is being rapidly pushed forward at the Fort plant.

The design of the new boats was carried out in the Division of Design, Bureau of Construction and Repair, under the direction of Naval Constructor Stocker, U. S. N., and in the Bureau of Steam Engineering, under the direction of Rear Admiral C. W. Dyson, U. S. N. A model was made and tested in the experimental tank at the Washington Navy Yard.

Mr. Ford's offer to build naval vessels at his plant was made in a letter dated December 22, 1917. On December 31, after a visit to Washington and consultation with the chiefs of the Bureau of Construction and Repair and the Bureau of Steam Engineering, Mr. Ford and his staff were given preliminary plans and specifications of the boats to be built, and on January 12 complete plans were delivered to representatives of the Ford Company. On January 15 Mr. Ford telegraphed his proposition to the Navy Department, and on the 17th the Department telegraphed the award to the Ford Company for building a large number of the boats. On February 17 the keel of the first boat was laid.

PERSONAL

CAPT. C. S. BOOKWALTER, formerly agent of the United States Shipping Board Emergency Fleet Corporation, in charge of the New York district, has been appointed assistant to Rear-Admiral F. T. Bowles, in charge of the Government shipyards, with headquarters in Philadelphia.

H. L. JOYCE, manager of the marine department of the Central Railroad of New Jersey, has been appointed by the Mayor of New York city manager of the National Defense Committee.

GEORGE H. SHAW, for the past five years sanitary engineer of the United States Department of Agriculture, has been appointed sanitary engineer with the United States Shipping Board and Emergency Fleet Corporation.

JOSEPH N. PEW, JR., has been elected president of the Sun Shipbuilding Company, Chester, Pa., to succeed his brother, J. Howard Pew, who becomes vice-president of the company.

STEPHEN H. COSSEY, Tottenville, N. Y., an expert in wooden ship construction, has been appointed traveling inspector by the United States Shipping Board Emergency Fleet Corporation, to speed up wooden ship construction.

W. J. SERGENT, superintending engineer of the Allen Line and Canadian Pacific Ocean Services, has retired from active service after eighteen years' association with the company. Mr. Sergent continues as an official of the company in a consulting capacity.

KENNETH MACKENZIE, M. Eng., chief assistant to the superintending engineer of the Canadian Pacific Ocean Services, Ltd., has been appointed chief superintending engineer of all the company's fleets, with headquarters in Liverpool, vice W. J. Sergent, retired.

W. H. PLEASANTS, of New York, president of the Ocean Steamship Company, has been appointed manager of the marine section of the Government Railroad Administration, and will have charge of the Coastwise and Great Lakes Steamship Lines operated by the railroads.

DAVID H. E. JONES, head of the old shipping house of James W. Elwell & Company, New York, agents of the Fabre Line, has been decorated by the French Republic with the cross of the Legion of Honor.

L. A. BAIER, formerly chief, scientific department, Seattle Construction & Dry Dock Company, Seattle, Wash., has removed to 2507 Madison avenue, Baltimore, Md.

F. E. PRATT, who has been connected with engineering matters in the marine field for many years, is now connected with the sales department of the Steam Motors Company, of Springfield, with offices at 30 Church street, New York.

OBITUARY

HARVEY C. BEESON, publisher of Beeson's Marine Directory, Chicago, died on February 13.

ADAM COOK, head of the firm of Adam Cook's Sons, dealers in lubricating oils, died recently in New York, aged 52.

HENRY B. NEWHALL, founder of the Newhall Chain, Forge & Iron Company of New York, died recently at his home in Littleton, N. H., aged 74.

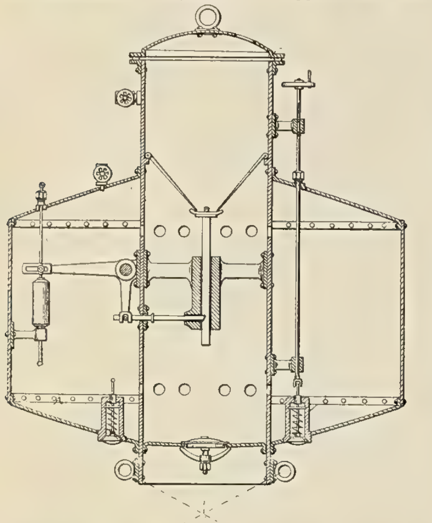
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,240,180. MEANS FOR RAISING SUNKEN VESSELS. RAFAEL DE ARAZOZA, OF HABANA, CUBA.

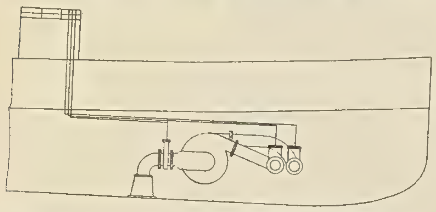
Claim 1.—In a float, a body, a cylindrical gas generator concentrically arranged within said body and containing a chamber for the gas generating compound, a support for the



collapsible bottom of said chamber, a latch or trigger normally maintaining said support in its raised position, means for operating said trigger for releasing the support and means for regulating the air and water supply and exhaust. Two claims.

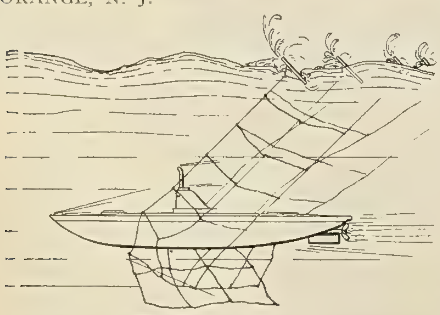
1,240,932. DREDGER. WM. BROWN AND WALTER BROWN, OF RENFREW, SCOTLAND.

Claim.—In a dredger, in combination, nozzles located one at each side of the bow, a pair of pumps located adjacent to said nozzles, pipe connections leading from the discharge



side of each pump to both nozzles, water supply pipes connected to the inlets of said pumps and penetrating the bottom of the dredger hull, valves operable from the dredger bridge to control the supply and outlet pipes and to determine which nozzle will be supplied with water, and a common diaphragm for cutting off communication between either pump and said nozzles, substantially as and for the purpose set forth.

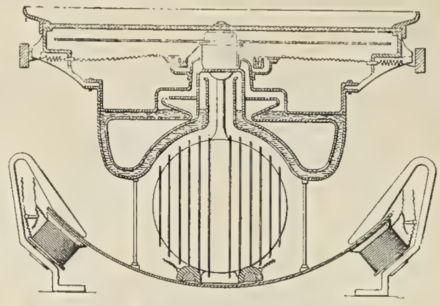
1,242,386. SUBMARINE DETECTOR. WILLIAM A. STEWART, OF EAST ORANGE, N. J.



Claim 3.—A submarine detector comprising a submerged device of considerable area, means for mooring the device sufficient to prevent drifting, and a series of floats connected to the device and inconspicuous when moored but conspicuous when the device is engaged by a moving body and the floats are towed by the device. Eight claims.

1,242,065. SHIP'S GYROSCOPIC-COMPASS SET. ELMER A. SPERRY, OF BROOKLYN, N.Y., ASSIGNOR TO SPERRY GYROSCOPE COMPANY.

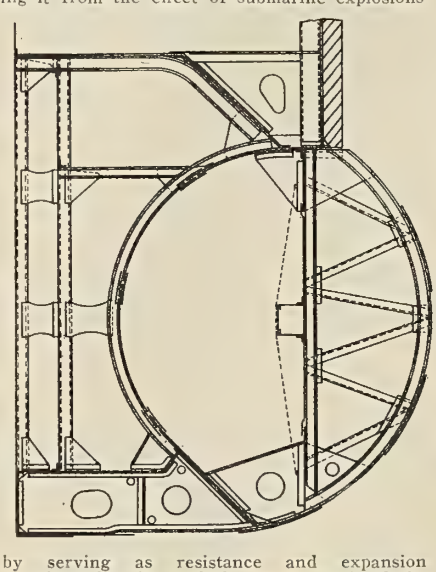
Claim 1.—In gyro navigation apparatus, a gyro wheel including an electrically driven part, a float for supporting the gyro in stable equilibrium, a central guiding member independent



of said float for confining the motion of the gyro and float, a mercury cup into which the guiding member dips, electric circuits for the apparatus including said guiding member and an insulating support for said guiding member. Thirty-four claims.

1,246,494. WARSHIP AND OTHER SEA-GOING VESSEL. THOMAS GEORGE OWENS THURSTON, OF WESTMINSTER, LONDON, ASSIGNOR TO VICKERS, LTD.

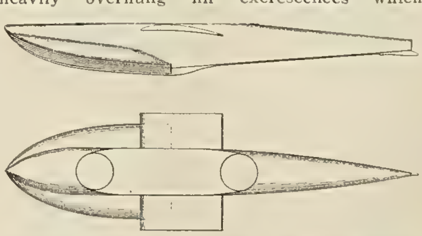
Claim 1.—A vessel having along its side a series of chambers for the purpose of protecting it from the effect of submarine explosions



by serving as resistance and expansion chambers for the explosion gases, each of the said chambers, comprising a voluminous outer compartment having an outer wall which projects beyond the usual and normal contour of the vessel, and an inner compartment of strong structural form. Ten claims.

1,246,019. FLYING-BOAT HULL. GLENN H. CURTISS, OF BUFFALO, N. Y., ASSIGNOR TO CURTISS AEROPLANE AND MOTOR CORPORATION.

Claim 4.—A flying boat including a hull having its bottom area laterally increased by heavily overhung fin excrescences which



emanate from the extreme bow and extend continuously outwardly and rearwardly to a point of maximum beam and hence rearwardly substantially in parallelism for termination at a point in the transverse vertical plane of a line projected vertically through the center of gravity. Six claims.

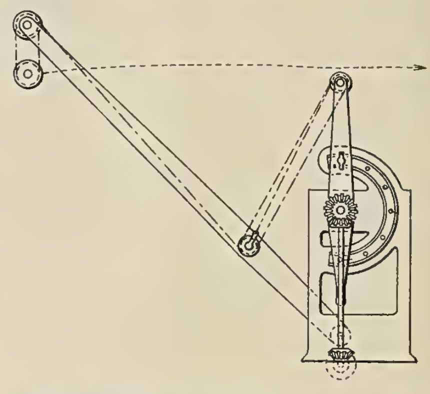
1,239,999. EMPTYING AND FILLING THE BALLAST-TANKS OF SUBMARINE VESSELS. HAROLD EDGAR YARROW, OF SCOTSTOUN, GLASGOW, SCOTLAND.

Claim 1.—In a submarine vessel, the combination, with the valves of a group of ballast tanks; of a controlling member which, by its position, determines the setting of all of said valves, at whatever parts of the vessel they may be placed; and non-rigid means, adapted to open and close the valves, connecting said controlling member with each valve. Ten claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

108,550. "IMPROVEMENTS RELATING TO SHIPS' DAVITS." J. STORIE, EDINBURGH.

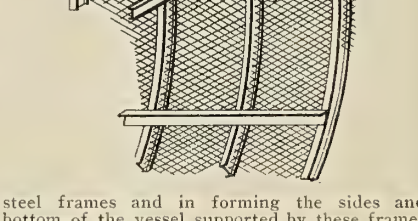
This invention relates particularly to ships' davits which are luffed or tilted outboard in a vertical plane. The object is to provide improved methods of compensating for the lowering of the davit head, and also to compensate



for the vessel taking a list. In this invention a simple means is provided of changing the path taken by the boat, so that the boat's course may be set with a considerable downward or upward inclination to its former course, and the boat can be moved outboard in a horizontal line even when the ship has a heavy list, no increase in the driving or controlling power being required.

110,423. "IMPROVEMENTS IN AND RELATING TO THE CONSTRUCTION OF OCEAN-GOING STEAMSHIPS AND OTHER LIKE VESSELS." J. C. GRANT, OF LONDON, S. W.

The invention consists in constructing an ocean-going steamship or other ocean-going vessel by forming the framework in the usual way as for a steel or iron plated vessel of iron or



steel frames and in forming the sides and bottom of the vessel supported by these frames of ferro-concrete or ferro-cement, the whole forming a monolithic structure roughly in the form of a half cylinder forming a monolithic decked vessel having its own means of propulsion. The invention further consists in constructing the vessel with frames of double T-shaped section arranged at a distance from one to two feet apart, connecting such frames by longitudinal rods passing through apertures in the frames, placing suitable molds in contact with the frames on the inside and the outside and filling in with concrete or cement to form the walls of the vessel.

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Vol. XXIII APRIL, 1918 No. 4

Buy Liberty Bonds

NO delusion exists as to why we are fighting Germany. We must win the war quickly, if possible. We must carry it on for years, if necessary. Let the cost be what it may, our sons and brothers are eagerly going to the front as quickly as we can send them over, and support them. To do this, however, calls not only for an honest day's work from every able-bodied man in the country every working day in the year but it also calls for money. Two huge loans have already been generously over-subscribed as evidence that our hearts and souls are in the work, but we have only begun to prepare to do our share. A third loan is now called for. This is your opportunity. Remember that there is no surer way of betraying our men in France to the enemy than by stopping the industrial home work. Invest your all and speed the victory. Buy Liberty bonds!

Progress in Shipbuilding

ALTHOUGH this is our annual shipbuilding number, war conditions make it inadvisable to publish a complete record of the output of American shipyards during the past year and the amount of work on hand at the beginning of the current year, as has been our custom in the past. Figures published by the Shipping Board, however, give some idea of the magnitude of the Government shipbuilding programme and the progress which has so far been made towards its completion.

On March 1 the total amount of steel ship construction in hand was 8,205,708 deadweight tons, made up of 5,160,300 deadweight tons under contract for the Emergency Fleet Corporation and 3,045,408 deadweight tons of requisitioned vessels. The work which has so far been completed on this tonnage is equivalent to about 28 percent of the programme. Since the Shipping Board began its shipbuilding operations, 188 vessels have been launched, of which 103 have been completed and put into service. The launchings were divided between 165 requisitioned vessels and 23 vessels which were built on contract for the Shipping Board in yards that were especially constructed for the purpose, or which had only just been put into operation. Eleven of the vessels launched were of wood, the remainder being of steel. Of the steel ships under contract and under requisition, 655,456 tons deadweight, or approximately 8 percent of the total, were actually completed and in service on March 1, 1918. This exceeds the total output of American shipyards in 1916 by approximately 50 percent. Put in another way, nearly as much tonnage has been constructed in American shipyards in the first quarter of 1918 as by all the other maritime nations of the world.

The magnitude of the task which the Shipping Board has undertaken is shown not only by the total amount of tonnage contracted for or requisitioned but also by the tremendous expansion of shipbuilding facilities in the past twelve months. When the Government programme for building merchant ships was started there was no shipyard in the country where an order could be placed. Seventy percent of the capacity of the established yards was engaged in naval work and the remainder was filled to capacity for several years with orders from private shipowners and for foreign account. Under these conditions, it was necessary not only to build new shipyards but also to get experienced shipbuilders to take charge of them and to train inexperienced men to build the ships.

Eight months ago there were only 37 shipyards in the United States equipped for building steel vessels. At that time these yards had 162 shipways: at present they have 195 shipways. Thirty new steel shipyards with 203 shipways are now being erected, so that the Emergency Fleet Corporation will have a total of 398 shipways for building steel vessels. Thirty-five of these yards, with 258 ways, are on the Atlantic and Gulf coasts; 19 yards, with 66 ways, on the Pacific coast, and 13 yards, with 74 ways, on the Great Lakes.

For building wooden vessels, there were in existence 8 months ago 24 yards with 73 shipways. The Shipping Board now has 81 wooden shipbuilding yards with 332 ways completed or nearing completion. Assuming that two wooden ships will be built on each way in a year, the annual output of wooden vessels should reach 2,300,000 deadweight tons.

Recapitulating the above figures, the capacity of American shipyards has increased in less than a year from a total of 235 shipways, made up of 162 for steel vessels and 73 for wood vessels, to a total of 730 shipways, 398 of which are for steel vessels and 332 for wooden vessels. With 730 shipways, the United States will have 521 more berths for building ships than has England at the present time.

"Fail With Ships and We Fail Utterly"

WITH the above utterance by the chairman of the Shipping Board challenging the country, can any one of the thousands of men employed in the shipyards of America falter for an instant in the faithful performance of his duties, however humble they may be?

We are fighting for liberty and freedom. Stern realities cannot be evaded. The submarine has not been vanquished from the high seas. Its menace has been slightly lessened, but since the war began nearly 12,000,000 tons of shipping have been sunk and less than 7,000,000 tons have been built. Can these facts be faced by shipyard workers without an instantaneous response to our country's needs?

Upon their efforts, says Chairman Hurley, rests the whole burden of making American victory possible. Delays mean defeat. An honest day's work every working day in the year is required of every man employed in the

shipyards of America. Every hour is priceless. Speed up the ships!

The Government Assembling Yards

By far the most spectacular feature of the Government shipbuilding programme is the extent to which the new method of building ships, popularly known as "fabricating" ships, has been adopted. So great a saving in time of production will result from this method, it is estimated, that the three great assembling yards which the Government has built—one at Hog Island, Philadelphia, with 50 ways; one at Newark, N. J., with 28 ways, and one at Bristol, Pa., with 12 ways—will, when in full operation, be able to produce in a single year more ships than England, the greatest maritime nation in the world, has ever been able to turn out in the same length of time.

These three yards are now so far advanced that shipbuilding operations have already begun; 13 keels have been laid at the Newark plant, 4 at Bristol and 2 at Hog Island. In all the yards the same general principles govern the operation, but, as each yard is building a different size vessel, the arrangement and equipment differ materially. We regret that the policy of the Emergency Fleet Corporation will not permit us to publish complete details of the construction and operation of these yards, but brief descriptions authorized by the Shipping Board will be found in the following pages.

In design, the fabricated ships do not differ materially from ordinary cargo vessels, except that they are simplified to include as much straight line and flat work as possible, and also to reduce to a minimum the number of operations that will be required in fabricating and erecting the separate parts of the hull. The general plans and a detailed description of the 5,000-ton vessel which is being built by the Submarine Boat Corporation at the Newark Bay plant (published here for the first time) will also be found elsewhere in this issue.

Fair Play For Our Flag!

In the article published on another page of this issue—"American Classification for American Ships"—facts are set forth that demand frank attention of the officials of the United States Shipping Board, in Washington. Marine Engineering pointedly referred in the December issue to the unwisdom of allowing a distinctively foreign concern to supervise the construction of American ships building for the American Government. Mr. Marvin, in his article in the present issue, recalls certain facts in our maritime history which ought to prompt the Shipping Board to execute a square "about face" and eliminate the British Lloyd's at once and forever from all authority over American ship construction.

Most of our enormous military expenditures now being made to beat Germany and save our Allies will leave no trace after the war has ended. But our vast new merchant fleet will remain, and with prudent direction may prove a highly valuable asset to the American people and their Government. A great merchant marine, however, is more than a mere matter of ships; these ships must have a fair and dependable classification in order to be able to command all-requisite insurance for themselves and for their cargoes. What suicidal madness is it that would leave this classification, and thereby this insurance, to the whims of an absolutely alien society created and maintained for the express purpose of promoting the trade and navigation of the nation that traditionally has been, and certainly will be, our greatest and most formidable antagonist?

The British Lloyd's Register and Lloyd's underwriters have a long record of savage discrimination against American shipbuilders and shipowners which cannot be recalled at this day without an indignation that well nigh chokes utterance. What they have done once they will most assuredly do again if we ever give them an opportunity. There might be some excuse for allowing Lloyd's to finish its work upon those steamers now building in American yards that were originally ordered for the British government and now have very properly been commandeered by our own authorities, but right at this point toleration must cease. No new contracts must be made, and Lloyd's surveyors must be left to depart as quickly as possible for their rightful place on the other side of the Atlantic Ocean.

We can build our own ships—we can design them, and we can survey and classify them through our own American Bureau of Shipping, created for the purpose, which it can now abundantly fulfill, of performing the same service for the United States which the British Lloyd's for so many years has been performing for the British Empire. We bear our British kinsmen no ill will, but they are one people and we are another. We have a government of our own; we have a navy of our own; we have —or we are going to have—a merchant marine of our own, and in order to have it and to keep it we must have a distinctively American inspection, survey and classification service as the vital prerequisite of an American system of marine insurance.

By no single step can the Shipping Board strengthen itself more decisively with the nation and clinch the future success of the American merchant marine which it is building than by causing it to be known at once that just as fast as the ships which the British Lloyd's is now supervising are completed the services of Lloyd's will be dispensed with and the inspection, survey and classification of all the other vessels being constructed for the American people in American yards with American money will be reserved to loyal and competent American hands.

This prudent, patriotic policy inflexibly maintained will assure our country of a classification society greater and better than Lloyd's when the work is completed, and of American underwriting resources sufficient, when the war is ended, to give all our new American ships fair play for cargoes and insurance in all the ports and all the commerce of the world.

Short Cuts and Innovations

Never before has there been a time when short cuts and new methods of speeding up production in shipbuilding were more eagerly sought. New ideas and schemes have been offered by the hundreds, but few give tangible evidence of practical value. With the successful launching of the 5,000-ton concrete ship *Faith* last month, a new impetus is given to the development of concrete shipbuilding, an innovation to which the Shipping Board is already committed. Similarly, a corporation has been formed to build an experimental 10,000-ton cast steel ship, another project which may be sound in theory but regarding which practical experience and tests are lacking. The electric welding of steel plates is also being tried out at some of the shipyards with a view to its utilization in the construction of steel ships. If successful, these innovations in shipbuilding will offer numerous advantages in the race for more rapid production of tonnage. If they fail, the money spent in investigation and experiment will mean only a trifling loss, and the sooner the truth is known, the better.

A special message from the CHAIRMAN OF THE SHIPPING BOARD

To the Shipbuilders of America!

TO you falls the task the successful accomplishment of which will determine the result of the war. Upon you rests the whole burden of making American victory possible. Patriotism demands your greatest effort. Can you give to your country the best that is in you in this hour of danger to the civilized world?

Our factories are working overtime to provide the materials and supplies needed by our army abroad and our Allies; American farms are raising the food that must be sent across the seas if England and France are to survive. Our railroads can carry the war material and the food to port, but without ships their efforts are in vain. Food will spoil on the piers and be wasted; Pershing's army in France will be a burden rather than an agency of delivery for the suffering people.

Increase the world's tonnage and American supplies will flow steadily and in ever-increasing volume across the Atlantic. I believe that American mechanics can do this great thing and do it quickly and well. Once they realize the great need for ships, nothing can prevent successful accomplishment of their task, but it will require an honest day's work every working day by every man employed in the shipyards of America. It will require constant vigilance to detect and expose the shirkers; it will demand a spirit of confidence and a will to win.

Give us all that and the submarine will be vanquished from the high seas and the people of the world assured of freedom.

Edward N. Hurley

The Organization of the Emergency Fleet Corporation

by WALDON FAWCETT

FORMIDABLE as are the problems of practical ship construction that must needs be solved in hot haste for the realization of the war-inspired dream of an American merchant marine, they are all but paralleled in responsibility by the problems of organization. To create within the span of a single year the complete administrative machinery for the greatest shipbuilding enterprise ever undertaken under one management has been in itself a herculean task, but to grasp the full significance of this achievement it must be borne in mind that this huge executive staff has had no opportunity to work out its own salvation with singleness of purpose, so to speak. Even as the new organization has been "finding itself," it has been necessary, again and again, to turn aside from the problems of organization to concentrate on constructive work in the field—the field meaning in this instance our entire far-flung coast line.

Mushroom Growth of the Corporation

The mushroom growth of the Emergency Fleet Corporation is not, perhaps, better indicated than by the manner in which the executive offices have overflowed the limited facilities available in Washington. Indeed, the problems of housing the shipyard workers have not overshadowed in depth of perplexities the necessities of providing working space for hundreds of executives and clerical workers. From that standpoint it might be urged that Washington is not an ideal headquarters for so vast an industrial enterprise; but, for that matter, what community would have been qualified to extend instant hospitality to an institution comparable in magnitude only to the United States Steel Corporation? This is the answer to the efficiency expert who regrets that decentralization represented by Fleet Corporation occupancy of fourteen rented office buildings scattered throughout the business district of the capital. When requirements expand in a twelvemonth from a suite of four offices to several thousand rooms—an aggregate of about eight acres of floor space—business beggars cannot be choosers.

Office Space at a Premium

That the process of organization of the Emergency Fleet Corporation should have been in any degree complicated by uncertainties as to office arrangements is, of course, to be regretted, but it is doubtful if the proposal which at one time was considered to move bodily to Philadelphia would have helped matters. Ultimately it is expected that Congress will perceive the extravagance of paying out upward of $200,000 (£41,000) a year in rentals, and will authorize the erection of a single big building that will provide space under one roof for all the divisions and departments of the Fleet Corporation.

Whereas the Fleet Corporation in the basic essentials of its organization follows the make-up of some of the most efficient private corporations in the shipbuilding field, it has from the very nature of things been necessary to amplify the framework. For example, the purchasing division, the production division, the executive and administrative division and certain others follow, in the main, the functions of their equivalents in private shipyard practice; but in the case of such units as the transportation division, the labor division and the national service division it has been necessary to undertake special responsibilities on a scale unknown to private shipbuilding practice.

As an example of the unusual obligations of this shipbuilding organization, there might be cited the responsibilities of the national service division, of which J. Rogers Flannery is manager and Meyer Bloomfield is assistant manager. No ordinary welfare work is the forte of this section of the organization. Superimposed upon the ordinary problems of sanitation and industrial service is the liability of housing the shipyard workers—a $20,000,000 (£4,100,000) project in itself. In order to create satisfactory living conditions for the shipyard workers, this branch of the Emergency Fleet Corporation has been vested with powers perhaps more autocratic than have ever before been conferred on a public or private organization. Not only may it build dwellings as needed, but it may commandeer existing buildings, dispossessing owners or tenants at will.

Housing and Transportation of Shipyard Workers

At that, the responsibility upon the service division presupposes no policy of blind confiscation. In the case of each shipyard to be served, the organization is authorized to resort to commandeering or to new construction only in the event that it is found that local transportation facilities cannot be adapted to the conveyance to and from work of large bodies of men for whom ready-prepared housing accommodations are available at points more or less distant. With the transit problem unsolvable and no chance to billet shipworkers on the population or to commandeer suitable residences, the organization may

proceed to construct. Even here, however, we see the manifestation of that standardization which is to be the keynote of Emergency Fleet administration.

Insurance of Ships and Plants in the Hands of the Fleet Corporation

Picking at random, as it were, another illustration of the burdens which distinguish the Emergency Fleet Corporation organization from the system characteristic of private shipbuilding, there may be cited the responsibilities of the auditing division with respect to insurance. The Fleet Corporation provides all its own insurance upon ships as well as plants, instead of placing the risks with commercial companies, and, in consequence, an important cog in the machine is the insurance department, which is in charge of all insurance operations. In passing, it may be noted, too, that the auditing division, under D. H. Bender, general auditor, exemplified another tenet of the Emergency Fleet code—namely, the effort for simplification of routine. The division has supervision over all matters of auditing, accounting, payments under contract, etc., but the mobilization work at Washington is handled by a surprisingly small staff, thanks to a field organization of district and local auditors in each division on the shipbuilding map. As a result of intensive work in the field, the reports that are received at auditing headquarters at Washington are, as one official aptly put it, "predigested."

Shipping Board to Operate the Ships

Readers of this magazine who are familiar in a general way with the relations between the United States Shipping Board and the Emergency Fleet Corporation realize, of course, that the latter might be designated the constructive end of a dual governmental enterprise. In other words, the Fleet Corporation builds the vessels, be they of steel, wood, concrete or composite construction—and be the contracts on a "hull only" or "complete ship" basis—and when the tonnage is completed turns it over for operation to the Shipping Board, which is, in effect, an operative department. Whereas the members of the Shipping Board may, in the capacity of trustees, control the Fleet Corporation and its policies, the active management of shipbuilding operations is in the hands of the Fleet Corporation, a body that, following disappointments in its early career, was reorganized last November in a manner to centralize authority much after the fashion that authority is vested in private shipbuilding corporations.

Speaking recently of the development of the Emergency Fleet Corporation, President Edward N. Hurley said: "The organization has been expanded not only with the idea of checking up and safeguarding the expenditure of the vast sum intrusted to our care, but with the idea of infusing both into the contracting shipbuilders and the workmen engaged in the art that degree of enthusiasm for the work and interest in it that is absolutely essential to the carrying out of our purpose. We have recognized that it is necessary not only vastly to expand the number of men, and therefore to evolve a method of getting an adequate supply of labor and training it if necessary, but we have also been convinced of the necessity of spending more time in training up the executive and technical organizations in those plants which have undertaken contracts for which their experience does not particularly fit them. The big problem we have before us is to secure an adequate supply of experienced labor and competent shipyard organizations to direct it."

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Edward N. Hurley, Chairman of the Shipping Board

These remarks by the active head of the governmental institution disclose illuminatingly how intimate is to be the contact between the Emergency Fleet Corporation organization and the private shipbuilding interests of the country engaged upon government work on any basis. Furthermore, the comment will enable the reader to estimate the importance of one of the least understood sections of the organization, namely, the shipyard plants division. This division, under the management of Rear Admiral H. H. Rousseau, U. S. N., not only determines the eligibility of existing shipbuilding plants for Federal contracts, with a view to the type of construction involved in each case, but acts in a supervisory or advisory capacity with reference to new plants which are planned in anticipation of participation in the Government's shipbuilding programme. This task in itself involves a wide range of responsibility and technical knowledge.

Scope of the Shipyard Plants Division

While on this angle of the subject it may be further added that the division of shipyard plants exemplifies perhaps just a little better than any other that extreme elasticity which has characterized the whole Emergency Fleet organization. The circumstance that new offshoots to the main body have been created "over night" cannot be taken as evidence of vacillation on the part of the men at the helm, but rather as evidence of a determination to obviate delays by close and direct supervision. Given jurisdiction over matters of fire protection at the shipyards, the shipyard plants division organized a department of fire protection to design and install fire protective systems. Latterly this has been augmented by a department of shipyard protection, which is entrusted, among other responsibilities, with the task of organizing among the employees shipyard fire departments. What seemed in

prospect to require a fine distinction between these two "safety first" departments is in reality represented by a sharply defined line and attests the possibilities of that specialization that is the keynote of Emergency Fleet organization.

Production Division

The fact that the chore of the Emergency Fleet Corporation is to an extent unappreciated by some outsiders, not merely the construction of new ships, but more particularly the fabrication of new facilities and the construction of new shipyards explains some unusual attributes of the makeup of the organization. Take, for example, the attention bestowed upon the production division, of which M. C. Tuttle is manager. To this division, one of the newest in the organization, might be ascribed by the layman the duties that in reality fall to the construction division. Instead of concerning itself with vessel construction, the division of production is to concentrate on equipment. On the one hand it speeds up the production and delivery of machinery and other equipment required for ships that are not turned over to the Government in a completed state. On the other hand, it aids private shipbuilders holding Government contracts to get delivery of equipment needed for the fulfillment of their obligations—a most important service in these days of freight embargoes, car shortage and labor shortage that is curtailing the output of many factories. It is via this channel that there will be established the contact between the Fleet Corporation and scores of accessory manufacturers, such as the makers of winches, steering gear etc., etc.

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Charles Piez, Vice-President and General Manager, Emergency Fleet Corporation

How the Contracts Are Handled

From the complexity of the relations between the Emergency Fleet Corporation and the various shipbuilding concerns that are carrying on construction on one basis or another, it is obvious that the contract division must assume a place of considerable importance in the organization. The burden of Manager George S. Radford and his aids is made all the heavier by the diverse forms of contracts that are negotiated. In the early days of the Corporation some contracts were let on the cost-plus basis —that is, under an arrangement whereby the contractor receives the actual cost of the vessel plus 10 percent. Latterly this form has given way to contracts at a flat price or on a definite fee basis. However, as wheels within wheels, we have variations of these standard contract forms. Thus, a flat-price contract may incorporate an agreement whereby the governmental institution engages to take care of expense involved by any increase in the labor scale that may go into effect after the signing of the contract. Similarly, provision has of necessity been made in many cases for increases in the cost of material, and the outcome of this contracting policy has been to impose upon the contract division a vast amount of preliminary correspondence.

The contract division has done much for the stabilization of the American shipbuilding industry in general by its efforts to see to it that no attempt is made to, so to speak, jam square pegs into round holes. Contract Manager Radford, who has, in days gone by, drawn contracts for the Remington Arms and some of the largest manufacturing establishments in the country, as a prelude to contract negotiation, investigates not merely the shipbuilding experience and financial responsibility of each prospective bidder, but likewise all the physical aspects of the proposition. He wants to know, for example, whether the site selected by a new entrant in the industry is well suited for merchant shipbuilding, and he is doubly anxious that no contract shall go to a new builder who plans to muster his operative force by taking away men from present employment in other shipbuilding plants. In order to facilitate the first-hand investigation that paves the way for actual contract making the contract manager turns to the district manager in the territory involved, and this local or district manager in turn assigns the actual investigative work to his inspectors, whose duties thus comprise all manner of "intelligence work" bearing upon new or proposed shipyards, as well as the routine inspections of shipbuilding work in progress that give the O. K. to payments on continuing contracts.

So much has been printed with reference to the shortage of man-power in the shipbuilding industry that there is little need to emphasize the opportunity which lies before the labor division of the Emergency Fleet Corporation which, under the direction of William Blackman, grapples with all phases of the problem of procuring and distributing men from mechanical trades as well as laborers to the various shipyards throughout the United States. A successful idea, as developed in this quarter, is found in the employment bureaus established by the Emergency Fleet Corporation. Where all shipbuilders in a given district, as, say, on Puget Sound or in the vicinity of Philadelphia, agree to employ all needed labor through the one central agency, it is found that the co-operation works to the advantage of all concerned. The labor division is called upon to appear in a conciliatory role when labor troubles arise, and it works at all times in close harmony with the "welfare" sections of the national service division in an effort to create an atmosphere of contentment in all shipyards.

The General Manager's Duties

If there is steady improvement in the relations between the shipbuilders of the United States and the Emergency Fleet Corporation it must be attributed in no small measure to the reorganization which has squared the administrative practice of the Fleet Corporation with that followed by large corporations in general. Under the rearrangement, the general manager is no longer clothed with absolute power over the entire conduct of affairs. As matters now stand, General Manager Charles Piez, who has been indefinitely "loaned" to the Emergency Fleet Corporation as a result of his work in conjunction with Messrs. Mason and Day on the productive committee that investigated the American shipyards, is an appointive officer to whom certain functions are delegated. As the reorganized Emergency Fleet Corporation stands to-day, the executive control of the management is vested in the president, who may delegate any of his powers to such officers as he may elect. In this connection it may be of interest to quote the reply which General Manager Piez recently made to a critic who was inclined to question his suitability for his post on the ground of his lack of practical shipbuilding experience. The come-back of Manager Piez was in this wise: "I have had engineering training and for many years acted as an engineer. The problems in any large organization are not wholly technical. There are many problems of policy, of management and of organization that are in most cases of greater moment than are the technical problems."

As is essential in order to preserve the proper balance whenever administrative direction is in non-technical or semi-technical hands, we find in the case of the Emergency Fleet Corporation executive authority supported by such technical aids as Rear Admiral Bowles, the assistant manager. The construction division, over which the latter has presided, has complete supervision over all matters connected with the design and construction of vessels, the control of production and the inspection of work upon vessels under construction. To the technical department within this division belongs whatever credit attaches to the evolution of the designs for standardized ships which have played so prominent a part in the policy of the Fleet Corporation—namely, the Ferris type of 3,500-ton wooden ships and the standard ships of 5,000, 7,500 and 8,000 tons, respectively, that are being fabricated in the agency yards of the Corporation.

Construction Division

It rests with the construction division and its subordinate technical department to conduct the distribution of contracts in accordance with the Corporation's prearranged shipbuilding programme, which contemplates the provision of so many cargo vessels of this size and of that. No contract prepared by the contract division after consultation with the construction division is, however, formally approved or signed until it has been passed upon by the legal division, under the direction of John Barton Payne, general counsel. Indeed, whereas the contract division handles all the preliminaries incident to contract making, not forgetting investigations of credits, it is the legal division which actually draws up the contracts after the general terms have been agreed upon. Logically, then, it is this selfsame legal division which later handles all questions arising with respect to the obligations of the Corporation under its contracts and that considers all claims made against the institution by shipbuilders under contract or other interests.

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James O. Heyworth, Manager, Division of Wood Ship Construction

Purchasing Division

The Emergency Fleet Corporation, as becomes a going concern, has its purchasing division for the purchase of raw and finished products, but the incidents that during recent months have grown out of the difficulties encountered in getting the specified yellow pine necessary to carry out the wooden shipbuilding programme eloquently attest how far it is necessary for the division headed by General Purchasing Officer Frank A. Browne to exceed the activities of the ordinary industrial buying agency. It goes without saying that with upward of 400 wooden vessels under construction requiring an aggregate of close to 375,000,000 feet of Southern pine a man-size job

confronted the purchasing officers, and this responsibility was complicated when it was discovered that the timber required exceeded the total production of suitable long-leaf Southern pine for the year.

Difficulties Overcome by the Purchasing Division

It was in the face of this dilemma that the purchasing annex of the Emergency Fleet Corporation proved its ingenuity by placing representatives in the Southern territory who were not only able to communicate accurate information as to supplies, but likewise formed an effective organization for the conservation of such material as was available. For one thing, inspectors were placed at the mills to inspect every piece of lumber that came from the rack to determine its suitability for shipbuilding use. Then, finding that mill owners were yielding to temptation to sell lumber to private consumers who offered higher prices than called for by the contracts of the Emergency Fleet Corporation, the latter's purchasing division clapped on, through its field men, an embargo which has effectually prevented any interest from selling any lumber over 12 inches wide or over 2 inches thick that would be adapted for ship construction. The Corporation's purchasing officers were given authority to take over and operate any mill the management of which was detected in violation of the embargo, and the whole incident has been enlightening as to the power of a buying agency that must be reckoned with in all sections of the material market so long as Uncle Sam continues to build ships.

In the rapid expansion of the Emergency Fleet Corporation organization the greatest attention has been paid to the development of the agencies for the rendering of industrial service, using that term in its broadest sense. It was felt that the majority of the private shipbuilders of the United States, not having conducted, in the pre-war period, an especially profitable industry, might not have been able to adopt the best and most modern methods with regard to the employment of men and the creation of ideal working conditions. Accordingly, all the plans of the Fleet Corporation have contemplated the upbuilding of machinery designed not merely to recruit the shipyard forces to full strength, but to hold the roster at full strength and to maintain the morale of this industrial army at the highest point. We have the tangible manifestations of this ambition in such innovations as the shipyard volunteer reserve, and the department of industrial training, the latter having supervision over the training schools for training men for shipyard operations.

"Industrial Plattsburg" Established for Training Shipbuilders

The most important feature of the Fleet Corporation's industrial service work has been the effort to build up a dependable force of skilled labor for the shipyards by means of vocational training. With all American shipyards showing an average annual turnover of employees approximating 300 percent and with some of the largest yards disclosing annual labor turnover of 600 percent, there is manifest opportunity for anything calculated to put shipyard labor on a higher plane. The "industrial Plattsburg" that the Fleet Corporation has sponsored is counted upon to turn out skilled mechanics at such a rate that by force of example and by the instruction imparted man-to-man by these non-commissioned officers of the shipbuilding army there will be created a qualified operative force at the rate of 50,000 per year. By way of meeting the shipbuilders half way in this vocational training drive, the Fleet Corporation allows to a shipbuilder the sum of $5 (1/0/10) per day for the tuition period of six weeks for every skilled man detailed to the Corporation's training school. To the shipbuilder who establishes a training center at his own yard the Corporation makes allowance of $1 (4/2) per day for each man (for an interval of 78 consecutive days), half of this allowance going to the shipbuilder and the other half to the employee as a bonus for taking the training. Likewise, contributory to the consistent effort to create a permanent organization of skilled shipyard operatives is the shipyard volunteers' movement, with its badge of honor and certificate of enrollment for every worker who enrolls for shipyard service when called upon.

In its threefold effort to assist the shipbuilders of the country to "get men—keep men—fit men," the industrial service department, or national service division as it is now known, proceeds in accordance with a definite formula. First of all, each shipyard is helped to organize a centralized employment department, so that an end will be put to promiscuous hiring and firing with its consequent high "mortality." The Emergency Fleet Corporation experts have proven to their own satisfaction and are now endeavoring to prove to the satisfaction of shipbuilders throughout the country that leakage of men from the yards will be greatly reduced if the power to engage and discharge help is lodged in one place—in the hands of one intelligent, well-paid, responsible man, in the case of each yard. The industrial service department of the Fleet Corporation, without presuming to dictate appointments, has recommended to shipbuilders who have asked advice various high-grade men for employment managers in the yards, and it is no exaggeration to say that the system is passing whereby every foreman and sub-boss in the yard can dabble with the employment proposition. It should perhaps be added that the idea at the Fleet Corporation is that all changes in shipyard personnel should be with the advice of the foremen or other executives, whose interests are most directly concerned, but the idea is to have men "cleared" in each yard through one office. In connection with the establishment of a centralized employment department, the national service division seeks to help each shipbuilding firm to perfect a system whereby additional employees will be called for only as actual needs develop, and means will be provided promptly to absorb newcomers as rapidly as they arrive.

Labor Problems Handled by National Service Division

A second activity on the part of the national service division has been the recruiting from technical schools and colleges of men qualified to assume subordinate positions of some responsibility. At the same time there has been conducted at the shipyards throughout the country a series of foremen's meetings designed to instruct foremen how to handle the working forces to the best advantage and in a manner to secure the greatest stability. Another move in this same direction—that is, in the effort to keep hold of the men once secured—aims to build up in each shipyard an elastic system of transfer. The purpose of such an adjunct to shipyard organization is, of course, to bring about the speedy shifting of misfits to other environment in the same yard where they might be able to make a better showing. In the last analysis, it is all part and parcel of the studied effort to reduce the shipyard turnover. And, as Rear Admiral Harris recently remarked, this goes to the very heart of the shipbuilding problem of the period. The erstwhile executive of the Fleet Corporation, when asked if his tentative prediction of 6,000,000 tons of shipping in 1918 would be realized, replied: "It is very apparent from talks with shipbuilders that unless we can do something at the yards to get more workmen and keep them there contented and keep them

from going away and prevent such continuous turnover it will be impossible to make any forecast and live up to it."

In the industrial service annex of the Fleet Corporation there is an exemption section which deals with a subject of vital importance to all shipbuilders, namely, the release from military service or liability to military service of men qualified for shipyard work. Under the existing selective draft regulations shipbuilders may secure the exemption of their men, or rather may secure the substitution of shipyard employment for military service. Going a step farther, the organization above indicated made an arrangement with Secretary of War Baker whereby valuable men who have been withdrawn from the shipbuilding industry and are actually in the army may be returned to their previous employment on request of the shipbuilder. Hundreds of men have by this arrangement been restored to the shipbuilding industry. Most of the men thus shifted obviously exert every effort to make good in the shipyards, because if they do not come up to the responsibilities which their discharge back to the shipyard contemplates, they can be certified for recall to the army. An integral part of this system is found in the obligation upon the Fleet Corporation and the employing shipbuilder to report during the first five days of each month to the proper local exemption board that each man upon whom the army has waived its claim is yet engaged in shipbuilding.

Whirlwind Campaign for Shipyard Workers

While the Emergency Fleet Corporation, through its national service division, is doing much work direct to build up a shipyard army—for example, the "missionary work" of the field men, who have been traveling to every technical school and college of any importance—other efforts are in co-operation with the employment service of the U. S. Department of Labor. We may observe how this "team work" is applied by turning to the case of the United States shipyard volunteers of the public service reserve, which, as the result of a whirlwind campaign has now reached its full quota of 250,000 enrolled men. Whereas a department of the Fleet Corporation has exploited this movement and has, as noted above, issued badges and certificates, the work of registration has been in the hands of the enrollment agency of the United States public service reserve of the Department of Labor, and it will be through the Department of Labor that the enrolled volunteers will be summoned to serve in the shipyards as the gradual expansion of the plants provides places for the recruits.

Gigantic Transportation Problems

Even with all the aid that may be given by means of special "priorities" and "exceptions" to freight embargoes, there is a heavy responsibility devolving upon the traffic department of a business institution that is larger than the Standard Oil Company, larger than the United States Steel Corporation, and, in point of expenditures, larger than the United States Navy Department. The transportation division of the Emergency Fleet Corporation, of which F. C. Joubert is manager, is, in effect, the equivalent of the traffic department of a large industrial corporation, and yet it stands in a class by itself by reason of two special factors involved. One is the magnitude of the operations required—the necessity of keeping traffic moving to and from not a single factory, but dozens of plants in widely separated sections of the country. The other unusual element is the extreme urgency of virtually all freight movements in which the Fleet Corporation has an interest. The every-day production plant in almost any line may be in urgent need of a given piece of equipment or one class of supplies, but with the Fleet Corporation, an industrial giant virtually created "overnight," the "must" tag is on practically every shipment, great and small. To the transportation division comes the plaint of the manufacturer who cannot get cars to load chain and the protest of the shipbuilder who, with a keel laid, finds progress arrested because of the non-arrival of steel.

Every effort is made to insure the requisite close co-operation between the purchasing division and the transportation division. The purchasing division has obtained its information in regard to what is to be purchased from the engineering department. Bids under the ordinary specification are asked within a short period, say ten days, and the submission of bids by telegraph is encouraged. When it comes time to place orders or close contracts the element of transportation is taken into consideration and the transportation division may be consulted as to traffic conditions in the territory involved. Every effort has been made to place with firms on the Pacific Coast contracts for equipment and supplies for the vessels building on the west coast, not merely in order to distribute the business as equitably as possible, but likewise to relieve to as great an extent as possible the tax upon transportation facilities.

Acting as the nerve center of 150 shipyards, more than half of which have been established during the past year, and spending money at the rate of from $3,000,000 (£615,000) to $5,000,000 (£1,025,000) per day, the Emergency Fleet Corporation has developed an administrative organization singularly qualified for grappling with a mass of problems, a large portion of which, as fate would have it, are problems somewhat beyond the scope of ordinary shipyard direction. Of the 1,570 members of the executive staff of the Fleet Corporation not all, by any means, have won their spurs in American shipyards, but a surprisingly large proportion, if they did not serve apprenticeship in the shipyards, have qualified by connection with interests closely akin to actual ship construction. That the majority of the Fleet Corporation executives have made good is eloquently attested by the offers that have come to these men from private shipbuilders of places in their organizations—offers so liable to prove distracting that General Manager Piez has lately found it necessary to appeal to shipbuilders not to take away any of his employees so long as the war continues. It is an organization that is expanding so rapidly that no organization chart is up to date for more than 24 hours, but it is an organization that will "carry on."

Our New Merchant Marine

BY HENRY HOWARD*

THE sea's call to our country's youth to-day is clear and strong. At no other period in our national life has need been greater than now for fearless men to carry our flag through stress of war and storm to foreign ports.

The American merchant mariner of to-day takes rank in the greatest of all wars—the ultimate struggle of Liberty with Force—beside his honored brothers of the army and navy, an exemplar of the strength and plenty of this free and chivalrous New World. In his hands we trust our trade; but more than this, we trust our honor, too. Neither shall perish so long as our mariners sail the seas.

On a thousand new ships now taking shape upon our shores American merchant sailors by tens of thousands will go forth without fear. Veterans in sea service will have trained the newcomers to the fleets—and so will be wrought a strong, close-knit, all-American personnel for our reborn merchant marine.

* Director of Recruiting Service, U. S. Shipping Board.

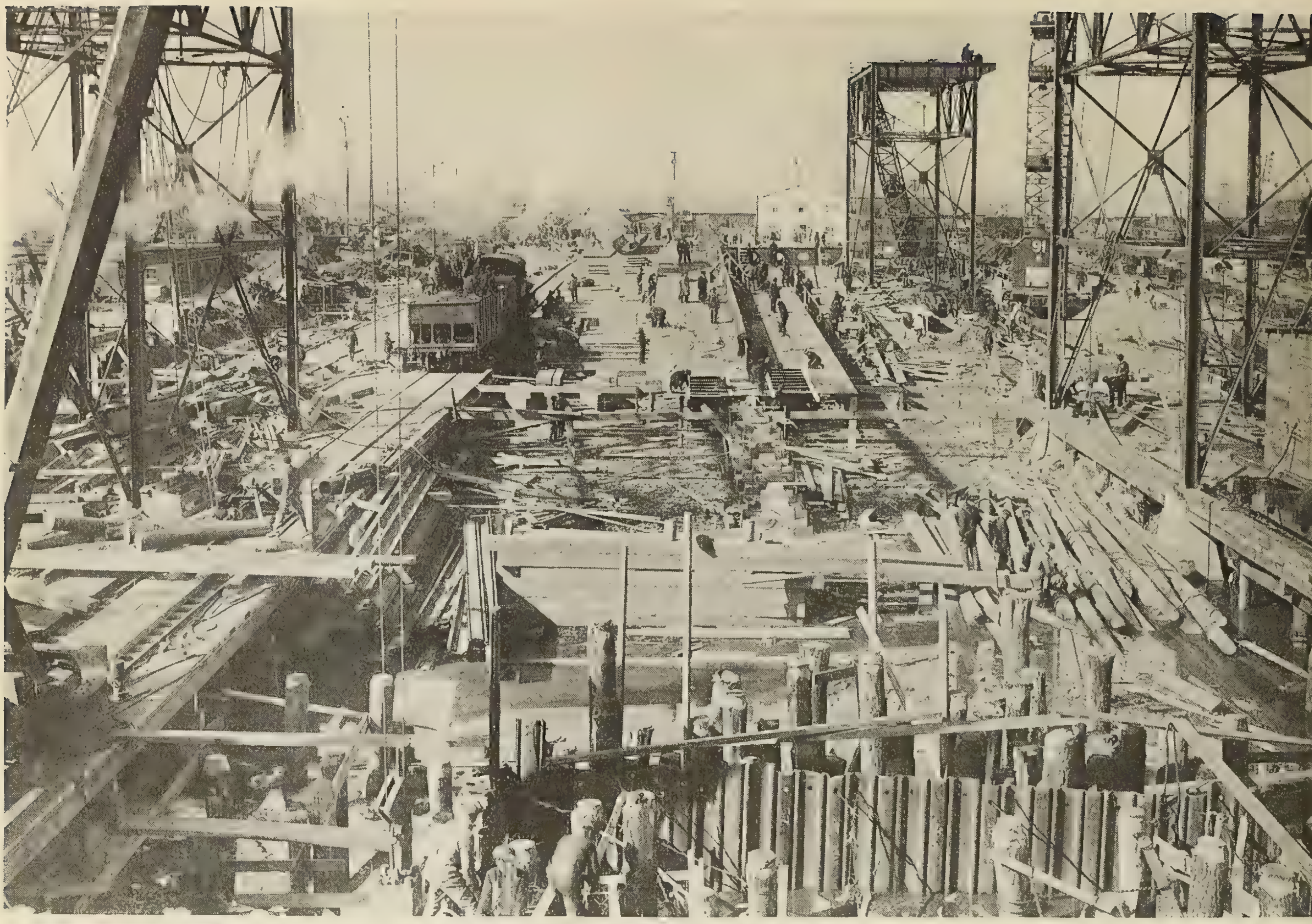

Fig. 1.—Cofferdam in Front of Shipway under Construction

Hog Island Yard Starts Building Ships

Great Government Plant Ahead of Schedule—Fifty Ships to Be Launched this Year—Over 30,000 Men Employed

NEVER before in the history of shipbuilding has such a colossal task been attempted as that assigned to the American International Shipbuilding Corporation by the United States Shipping Board, calling for the construction of nearly a million tons deadweight of merchant vessels within eighteen months. The undertaking involves expenditures amounting to two-thirds the cost of the Panama Canal and must be completed in about one-fifth the time required for that project.

To carry out this huge enterprise, a yard containing fifty building ways, and seven 1,000-foot fitting out piers, is being constructed at Hog Island, on the Delaware river, just below Philadelphia. This site, comprising 850 acres, has a water front of about two miles and extends back from the river about one mile. Although preliminary plans for the project were discussed with the Emergency Fleet Corporation last May, the contract calling for the construction of the yard, and the building of fifty 7,500-ton deadweight cargo vessels of 11½ knots speed, was not signed until September 13, and this was supplemented on October 23 by another contract for seventy additional vessels of 8,000-tons deadweight and 15 knots speed. For the construction of the plant, the American International Shipbuilding Corporation is to receive no remuneration, but it will receive a minimum fee of $41,000 (£8,400) for each of the smaller ships and $65,000 (£13,320) for each of the larger ships, with bonuses or penalties of $300 (62/10/0) a day for anticipating or failure to meet the contract schedule, the total bonus, or penalty, in each case being limited to $14,000 (£2,660).

Two Types of Ships to Be Built

The vessels are all single screw steamers, fitted with geared turbines and watertube boilers. The 7,500-ton ships are 401 feet long overall, 390 feet long between perpendiculars, 54 feet molded beam, 32 feet molded depth and 24 feet load draft. The hull is divided into five cargo holds with oil fuel bunkers alongside the boiler room. The 8,000-ton ships are 450 feet long overall, 435 feet long on the waterline, 58 feet molded beam, 40 feet depth to the upper deck and 28 feet load draft. The weight of the steel hull is 3,400 tons; the weight of the machinery (with water), 750 tons, and the total weight of the ship, light, 4,460 tons. With a deadweight carrying capacity of 8,000 tons, the total displacement is 12,460 tons and the gross tonnage 6,200. These vessels are fitted with geared turbines of 6,000 horsepower, designed to give a speed of 15 knots and a cruising radius of over 8,000 nautical miles.

Fig. 2.—Template Shop

The building of the ships will be carried out in eight-hour shifts, which with overtime and day and night shifts will keep the plant in operation practically continuously. About 35,000 men will be employed when shipbuilding operations are in full swing.

Speed of Construction the First Consideration

Speed of construction is the keynote of the whole project. As work was not begun until fall, it had to be carried out during winter months when the weather conditions were unprecedented in their severity. Delays in transportation, due to congested conditions of the railways, added to adverse weather conditions, imposed difficulties and hardships which could be overcome only by almost superhuman efforts. In spite of the initial difficulties, however, the work has progressed satisfactorily. All of the fifty shipways are well along toward completion. Ten are ready for keels, and construction of vessels has begun on two of the ways. It is confidently predicted that, barring unforeseen delays, fifty ships will be launched this year, and the entire contract completed on schedule time.

In the design and methods of construction of the vessels, the system of fabrication has been developed to take advantage of its maximum possibilities. Every detail of the ships has been worked out so that its manufacture in quantity requires the fewest number of operations. Ordinary ship lines are replaced by flat work in so far as possible; that is, the sides and bottom of the vessel are straight for the maximum distance amidships, the decks are without crown or sheer and other details are accordingly simplified. Over 95 percent of the steel that goes into the ships will be fabricated outside of the yard and delivered ready for erection and riveting. As originally laid out, the yard provided for the construction of a single type of vessel, but, with the later addition of a second size ship, it was found necessary to rearrange the yard and provide two separate main storage and classification yards for the material.

Essential Features of the Yard

As the yard is virtually an assembling plant, the essential features are the building ways, of which there are fifty, extending along a mile of the river front, the fitting out piers, of which there are seven, 1,000 feet long and 66 feet wide, and the material storage and

Fig. 3.—Administration Building

Fig. 4.—Group of Workmen's Barracks

classification yards, storehouses and such shops as are essential for the fabricating work, which is done in the yard. Thirty-six miles of railroad track have already been laid in the yard, and the buildings, including shops, barracks, mess halls, storehouses, training school, hospital, etc., will cover 20 acres. Twenty-five locomotives and 500 flat cars, owned by the Emergency Fleet Corporation, are operated in the yard. When shipbuilding operations are in full swing, 50 to 100 carloads of material will be received each day. Complete water and sewage systems are being provided of sufficient size, it is estimated, to serve a city as large as Minneapolis.

Construction of Shipways

The fifty shipways are laid out in groups of ten each, making virtually five separate shipyards. Ten of these ways are of concrete construction, while the other forty are of wood, supported on wooden piles. The ways are spaced 105 feet between centers, and for the 7,500-ton vessels, are 400 feet long, and for the 8,000-ton vessels, 450 feet long. Between each of the ways are four steel derrick towers, 66 feet high, 23 feet wide and 47 feet long, each of which carries two derrick booms of sufficient length to serve the entire width of the shipways; thus, each vessel will be served by eight derricks. The crane towers are offset on one side of the shipways to allow space for a railroad track to extend down to the water front.

To bring the depth of water in front of the ways to 18 feet, about 1,000,000 cubic yards of spoil is being dredged out. Further down the river, at the fitting out basin, where the present depth of water is 6 feet, about 3,000,000 cubic yards is being dredged out, the spoil being handled by hydraulic dredges and deposited in a marshy area back of the shipyard proper. The fitting out piers will have accommodations for 28 vessels at one time, and will be equipped with electric gantry cranes.

Railroad Connections

The yard has direct connections with the Pennsylvania and Philadelphia and Reading railroads, which lead into the storage and classification yards. The main storage yard is over two miles long, but holds material for only a two weeks' supply. In the storage yards the tracks are laid in groups of three, with a single track running through the center of the storage space between the groups.

Fig. 5.—Concrete Shipways

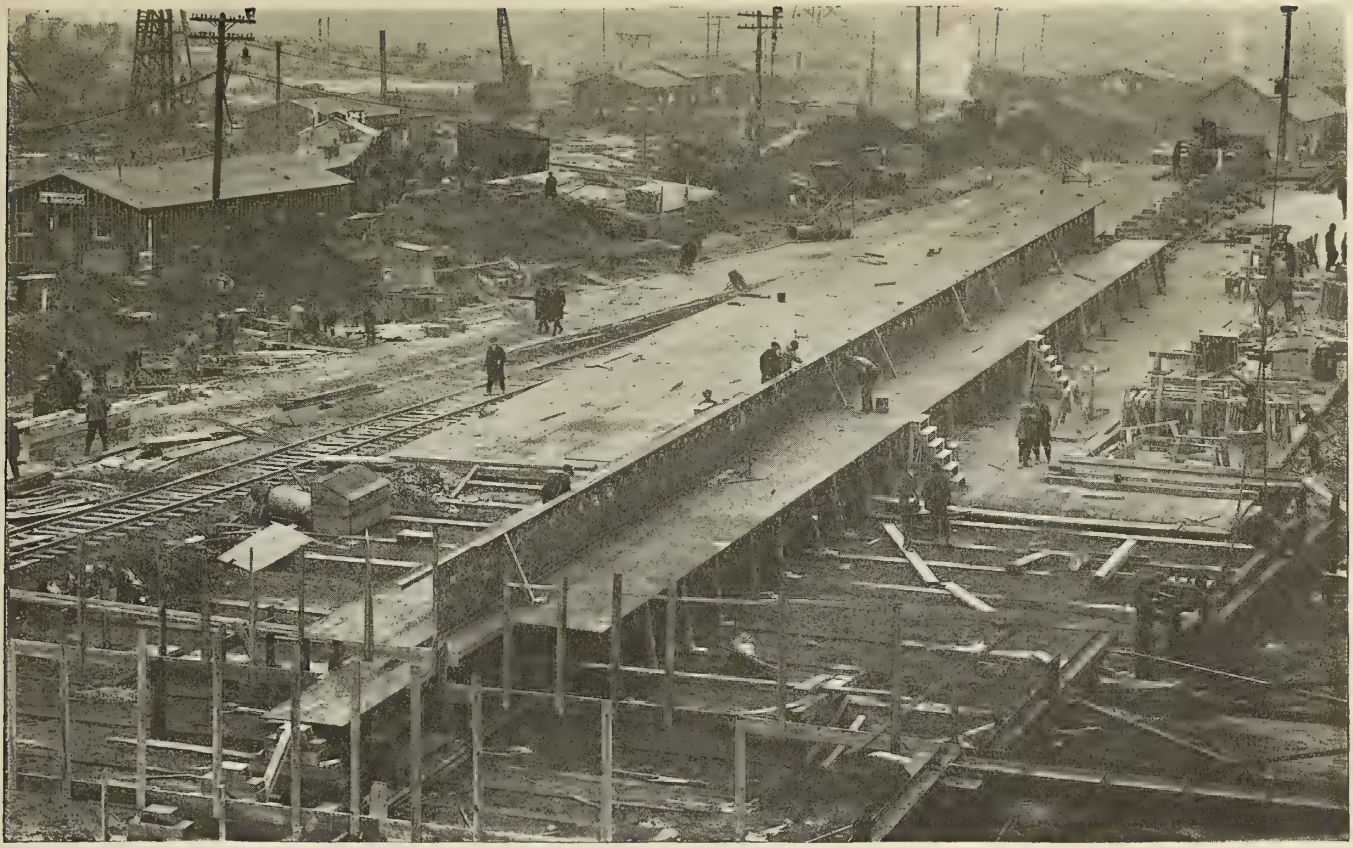

Fig. 6.—Laying the First Keel, Shipway No. 1

Fig. 7.—Shipway No. 1, from River Front

Shops and Service Buildings

Near the main entrance to the yard, which is at the center of the site, is a group of buildings, including a two-story, three-wing administration building, an engineering building containing the drafting departments, a brick bank building, a two-story hospital containing four wards with a total of 101 beds, garages and a fire-fighting station. Some of the principal shops are of large size, including a steel frame plate and angle shop, 638 feet long by 223 feet 3 inches wide, built on concrete foundations resting on piles. This shop is divided into three bays, served by six overhead traveling cranes of 10 tons capacity each. Foundations for the heavy machine tools are of concrete on piles. The floor is of cinder. Nearby is a plate and angle correction shop, of the same length, but one-third the width, of similar construction. There are two machine shops, each 200 feet long by 60 feet wide; two smith shops, one 275 feet long by 60 feet wide, the other 250 feet long by 60 feet wide, a smith annex, 120 feet by 60 feet; a pipe shop, 200 feet by 60 feet; a galvanizing shop, 100 feet by 50 feet; an air tool shop, 187 feet by 60 feet, and a template building, 400 feet long by 60 feet wide.

Template Shop

The template building is of steel frame construction with corrugated iron sides, up to the windows, which are in steel sashes. As the building is heated, it is sheathed inside, and there is a loft on one side of the building for the storage of patterns. The floor in this building is a special feature, and is entirely separate from the building itself. It is laid on 6-inch by 12-inch girders, spaced 10 feet apart and running lengthwise of the building, with joists 3 feet apart. The floor rests on piles with wedges driven in between the piles and the flooring, so that it can be leveled up at all times to a true flat surface for mold loft work. The floor itself consists of 2-inch, tongued-and-grooved yellow pine, running lengthwise of the building, over which are two layers of felt paper, topped by 1½-inch Michigan white pine uppers, painted gray.

There are also two separate buildings, known as boiler template shops, in each of which is to be assembled a complete boiler with fittings, for the ships under construction. At one end of the yard is a building 125 feet long by 23 feet wide, with an extension 20 feet by 23 feet, to be used as an instructor's training school for shipyard workers. This school is in charge of Dr. C. R. Allen, former head of the Department of Industrial Education in Massachusetts, and more recently in charge of the Emergency Fleet Corporation Training School at Newport News. The building will accommodate a class of 150 at one time.

Just outside of the yard are barracks for housing 5,000 workmen and two large restaurants. Sixty-two barracks have already been completed; one hundred are projected.

Power Supply

Power for operating the plant is taken from a local supply, the largest requirement being for the compressed air plants, which total 15,000 horsepower and compress 75,000 cubic feet of free air per minute, making this the second largest air compressor plant in the world. One compressor house is provided for each group of ten ways, each house containing three sets of electrically-driven air compressors, each with a capacity of 2,200 cubic feet. For driving the machinery in the yard, some 600 motors are required, totaling 28,000 horsepower. There is also a central heating plant and a high pressure pumping station for the general yard and fire service.

The keynote to success in carrying out the system of ship construction, adopted at this plant, lies in an elaborate system of production-control and transportation. The production-control system is so developed that it will be possible to tell, in a few minutes, the number of every article going into the ships, which is in the yard, the spaces available for material, the number of parts ordered and the number that are en route to the yard. Upon this production-control department and the traffic department rests the burden for speeding up the building of ships. At the work on the ways, the men are divided into specialist gangs, each performing one particular operation. These gangs serve on one group of five ways and are shifted from one way to the next for each particular job, so that as the work on the fifth way is finished, a new ship will be ready for the same operations on the first way. The same progress from hull to hull is then repeated. With this systematic progress of the work by gangs especially trained for one operation, it is believed the work can be speeded up to the maximum output of the yard.

Officers of the Shipbuilding Company

Both the plant and the ships are being designed and constructed by the American International Shipbuilding Corporation acting as agent for the U. S. Shipping Board Emergency Fleet Corporation, and supervised by Rear Admiral F. T. Bowles, assistant general manager of the Fleet Corporation. The officers of the company are: G. J. Baldwin, chairman, board of directors; Frederick Holbrook, president; H. D. Connick, M. A. Neeland, H. L. Rogers and G. O. Muhlfeld, vice-presidents; Walter Goodenough, general manager, and J. H. Manning, chief engineer. T. A. Carr is works manager; J. T. Martin (formerly general manager Sparrows Point yard, Bethlehem Steel Corporation), general manager of ship construction; W. B. Fortune (Quebec bridge builder), general superintendent ship construction and derricks.

Valves can be so fitted as to have the pressure come on top of the clapper or disk, and when opened a clear passage is obtained. Against this is the fact that it is difficult, if not impossible, to pack the valve stem under pressure. On the other hand, if the pressure is underneath the clapper, it is forced from its seat, and when the valve and body expand the valve sometimes leaks, but packing is made easy.

Valve stem followers are difficult to remove when once forced down as far as they can go, as then there is no space between the end of the stuffing box and the rim of the follower. It is a good plan to file away the underside of the rim, beveling on opposite sides so a screw driver can be used to start the follower.

The uniflow engine gains its enormous economy largely from the fact that the cooled steam at the end of the stroke is exhausted quickly, thus making the ideal conditions of keeping the cylinders nearer the temperature of the incoming steam.

It is easy to make one thing accurate; it takes skill to make two things alike and genius to make many things alike, cheaply.

It is to be remembered that each nut on a valve chest or cylinder cover is there to do its bit, so set them down evenly.

Fig. 1.—Main Group of Buildings at Newark Bay Plant

Construction of Newark Bay Shipyard

Submarine Boat Corporation, as Agents of Emergency Fleet Corporation, Building 5,000-Ton Fabricated Ships

WITH over 1,000 cities and towns in the United States directly or indirectly interested in supplying material, labor and equipment for the one hundred and fifty 5,000-ton shops it will build, the Government fabricated steel shipbuilding plant on Newark Bay, erected and operated by the Submarine Boat Corporation, of New York, as agent of the United States Shipping Board Emergency Fleet Corporation, is in reality but one department—the assembling department—of an enormous shipbuilding enterprise. Located at Port Newark Terminal, only about four miles from the heart of the city of Newark, and with railroad and trolley connections to a territory populated by over 7,000,000, the yard is ideally situated for shipbuilding purposes.

On a delta formed by the Hackensack and Passaic rivers, which formerly was a marsh, but which in recent years, has been filled in by soil dredged from two sides in the development of Port Newark Terminal, the yard occupies an area of 112.5 acres with a water front of over half a mile on Newark Bay, where twenty-eight shipways have been built. Originally the depth of water at the waterfront was insufficient, but this is now being dredged out by the Government to the main ship channel in the bay, which has a depth of 20 feet. On the south side of the property is a slip 400 feet wide with a depth of water of 20 feet and a complete wharf 50 feet wide and over 4,400 feet long, which will be used as a fitting-out berth.

In the yard 15 miles of standard-gage railroad track connects the storage yards, shipways, shops and fitting-out berth. These tracks are directly connected with the Pennsylvania and Lehigh railroads and with the Central Railroad of New Jersey, so that the fabricated material from outside structural and bridge shops can be delivered direct to the heads of the shipbuilding ways.

As the plant is in reality but the assembling department of the whole shipbuilding process, the major features of

Fig. 2.—Exterior View of Two-Story Administration Building

Fig. 3.—Shipway at Newark Bay Plant

Fig. 5.—Hotel and Restaurant

its layout center in the shipways, fitting-out berth and storage and classification yards. At the head of the shipways, which take up the entire water front, ample space is left for storing in front of each way all of the fabricated steel needed for a complete ship, one large derrick of 5 tons capacity with an 82-foot boom being provided at the head of each group of two ways. Back of this storage space is the main group of buildings with a two-story administration building in the center, flanked on each side by twin ship sheds and fabricating shops. Thus the hull building yard proper is divided into two separate units known as the north yard and south yard, but with identical equipment and arrangement.

Back of the main buildings, and also in the center of the shipyard property, is the main entrance to the yard, with a railroad station, restaurant, garages and hospital. On one side of the railroad tracks leading to the passenger station are the main storage and classification yards for ship steel and a lumber storage yard, while on the other side and adjacent to the fitting-out berth is the fitting-out storage yard. From the main classification yard, tracks lead direct to the shipways, shops and fitting-out berth. Between each group of two ways a single track extends down to the bulkhead at the water front.

Shipways

All of the shipways are of wood, supported on wood piles. The underlying soil is a soft, wet silt and clay extending to an average depth of about thirty-four feet below the ground level; below that, a five-foot layer of clay and gravel generally exists. The piles on which the ways rest, therefore, are usually driven about thirty-six feet into the ground, bringing up in the hard layer. The required bearing capacity varies from eight tons per pile under the inboard ways to a maximum of seventeen tons on the outboard ways. In all, over 26,000 piles are required for the twenty-eight ways. For the inboard end of the ways, which extends 310 feet from the water, 18,000 piles

Fig. 4.—Keel of Hull No. 4, Laid at Newark Bay Plant. View Shows Shipway Derrick Towers

Fig. 6.—Interior of Administration Building, Second Floor

are required. For the outboard end, the piles are driven out about 150 feet into the water. The bents are thoroughly braced and capped with timbers, above which are placed the stringers and flooring for the ways. The declivity of the ground ways is 11/16 inch to the foot, and of the ship's keel and flooring of the ways 5/8 inch to the foot.

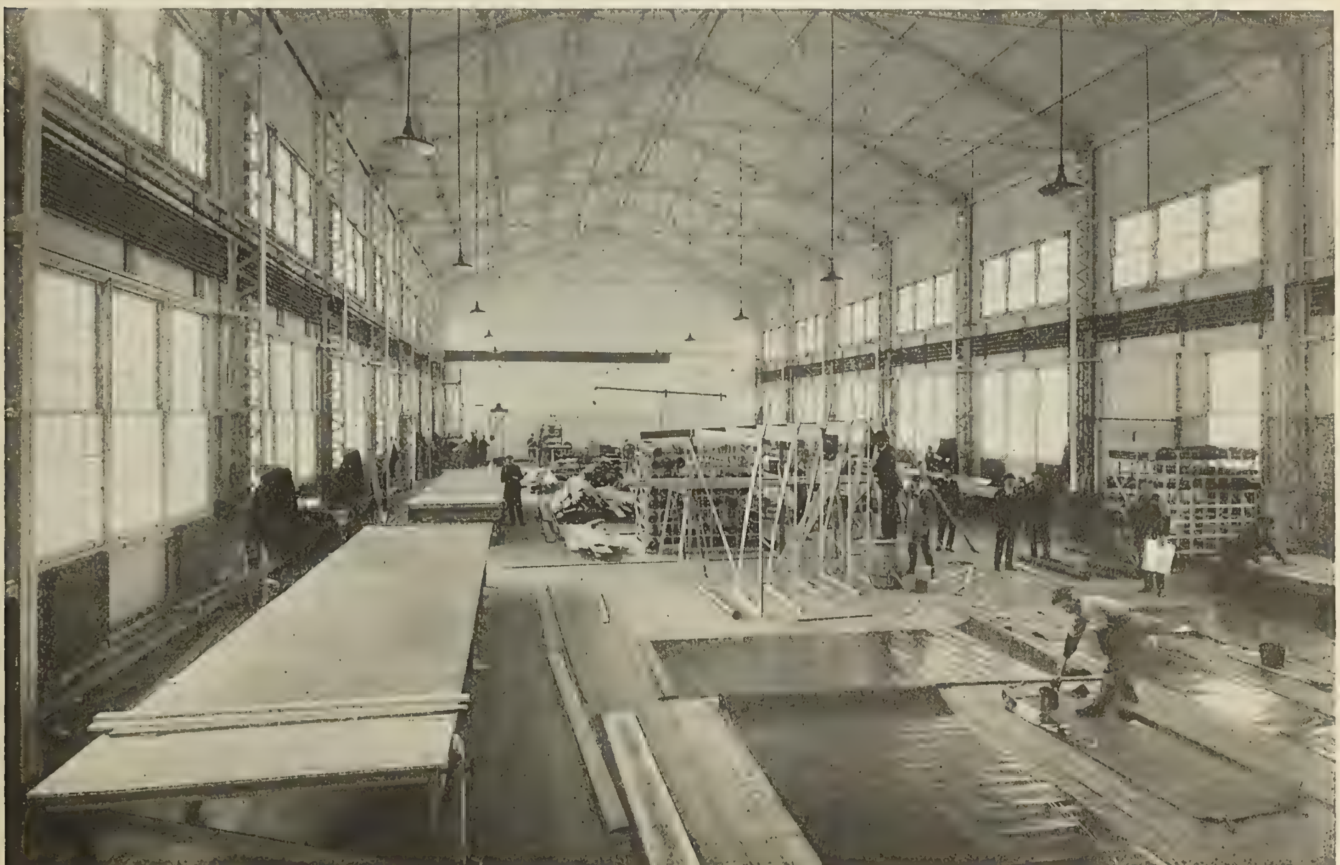

Fig. 7.—Interior of South Template Shop

At the head of the ways material is handled by derricks of 5 tons capacity with a boom of 82 feet, one being provided for each group of two ways. Between each group of two ways a railroad track extends down to the water's edge, so that material can be brought to any desired point along the length of the vessel. The material is transferred onto the ways by electrically operated derricks mounted on steel towers built between each group of twin ways, but on the opposite side of the way from the railroad track; thus between every shipway there is alternately the derrick cranes or the material track.

There are two derrick towers in each crane space between the ways, each tower carrying two derricks of 5 tons capacity and 87-foot radius. The derrick towers are each 28 feet wide and 74 feet long, extending up to a height of about 50 feet. The derricks are provided with separate motors and controllers for each motion; a 25-horsepower motor raises the load, a 35-horsepower motor raises the boom and a 5-horsepower motor swings the boom. For operating the motors direct current of 250 volts is required, but, as the current received from the Public Service is alternating and at 13,200 volts, two substations have been built for transforming and converting the current for the derricks.

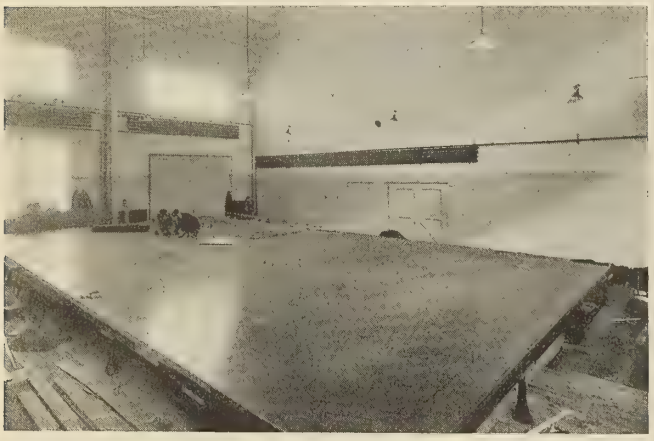

Fig. 8.—Scrive Board Room

Cranes at Fitting Out Berth

At the fitting-out berth, electric traveling gantry cranes will be installed for transferring materials and equipment to the ships after they are launched. The largest of these cranes, weighing about 400 tons and extending 90 feet above the pier, will have a capacity of 50 tons.

Turning now to the buildings, the administration building is 196 feet long by 80 feet wide, with wood frame and stucco and glass walls two stories in height. The main floor is given over to the purchasing department, inspectors and yard executives, while the second floor is occupied by the chief executives, the representatives of the Emergency Fleet Corporation and their staffs and the engineering and hull drafting departments.

Back of the administration building is a two-story hotel and restaurant, 76 by 96 feet, of wood frame with stucco walls. The kitchen is on the main floor, together with a dining room with a capacity for 144 and a lunch room with a capacity for 87. The second floor is divided up into several bedrooms with private baths, a private dining room and lounge and reading room.

On either side of the administration building are the main north and south shops, identical in size and arrangement. The total length of each of these shops is 635 feet and the width 60 feet. At one end is the furnace shop, 60 by 100 feet, with the plate and angle furnaces and bending blocks. In front of this is the punch shop with gantry punches and a straightening and bending machine. Beside the furnace shop are the scrive boards, and beyond that the template shop, 60 by 160 feet, equipped with a band saw, wood lathe, boring machine, edger and cross-cut rip saw. Beyond the template shop are the plate fabricating machines, consisting of a set of bending rolls, straightening rolls, plate planer, 60-inch plate punch, 15-inch detail punch, horizontal punch, bull dozer and wall radial drill. At the end is the smith shop. These buildings are of temporary construction, with light steel frame and corrugated iron walls bolted together, with the exception of the template building, which has stucco walls.

The machine and forge shops are housed in a building 40 by 240 feet, located alongside the railroad tracks back of the main south shop. At one end of the building is the machine shop equipped with three lathes, one 60 inches by 32 feet and the other two of smaller size, a 20-inch drill, a 24-inch shaper, a 5-foot radial drill, a bolt threading machine and drill and tool grinders. At the end of the machine shop is an electrical workshop, beyond that a storeroom, and then the forge shop equipped with a No. 3 Nazel power hammer, forge fires and pipe threading machines.

Along the fitting-out wharf are two buildings, each 420 feet long and 60 feet wide, which house a pipe shop, electricians' room, rigger and deck-fitters' stores, a carpenter and joiner shop equipped with band and circular saws, a boring machine, a planer and sizer and an edger. Next to this are rooms for plumbers and pipe coverers, and finally a sheet metal workshop. On the shore side of these buildings are storage spaces for the fittings and supplies belonging to the various departments.

The largest single power requirement in the yard is at the shipways, where seven air compressing plants use about 4,500 horsepower. The next largest power requirement is for operating the derricks at the shipways. The necessity for illuminating the ships and yard so that night shifts can work most efficiently and also to assist the guards in patroling the yard at night makes it necessary to furnish current equivalent to 1,500 horsepower for lighting purposes, or enough light for a city of 12,000 people. A heating plant is provided for heating the administration building, restaurant, template shop and hospital, all other buildings remaining unheated.

Entire Project Originated by Submarine Boat Corporation

It is to the Submarine Boat Corporation that credit is due not only for the original conception of this project but also for the design of the entire plant and of the ships they are to build. The layout of the plant, number of shipways, location of the buildings, etc., are original with the Submarine Boat Corporation. Since February 1, the yard has been under the personal direction of Rear Admiral F. T. Bowles, assistant general manager of the Fleet Corporation.

The construction of the plant has been carried out by the Submarine Boat Corporation under the supervision of H. C. Higgins, authorized representative, and G. A. Duncan, resident engineer for the Shipping Board. The officers of the Submarine Boat Corporation are: H. R. Carse, president; H. R. Sutphen, L. Y. Spear and G. C. Davidson, vice-presidents; T. C. Dawson, secretary and treasurer; F. E. Kirby, consulting engineer. At the Newark Bay shipyard the department managers are: B. L. Worden, general manager; George T. Horton, assistant general manager; G. A. Anthony, supervising engineer; C. T. Henderson, chief engineer; J. J. Scollan, manager hull construction, and J. P. Nicholas, purchasing agent.

Fig. 1.—Laying Keel at Shipway No. 3, Bristol Plant

Shipping Board's Bristol Plant

Shipyard and Industrial Town Built for Government at Bristol, Pa., by Merchants Shipbuilding Corporation

AT Bristol, Pa., where the third large Government fabricated steel ship building yard is located, the work of transforming an old manufacturing site and adjacent farm lands into a fully equipped shipyard, adequate for turning out sixty 9,000 ton cargo ships in eighteen months and a new industrial town for housing a population of 6,000, all within the short space of four months, marks an achievement remarkable not only as an engineering feat but also as an example of true American enterprise and ingenuity in meeting an emergency.

Here the work is being carried out for the United States Shipping Board Emergency Fleet Corporation by the Merchants Shipbuilding Corporation, of New York and Philadelphia, headed by R. H. M. Robinson, a former naval constructor, and controlled by W. Averell Harriman, son of the former railroad magnate. The site comprises about 600 acres, divided up into the shipyard itself, which has a waterfront of about 4,900 feet along the Delaware River and extends back about 1,500 feet from the river, and an industrial town site about 2,400 feet long and 1,200 feet wide, located between the shipyard and the main line of the Pennsylvania railway, which parallels the river.

9,500 Men to be Employed

Preliminary work in the construction of the plant began on September 7, 1917, and on February 20 the plant was practically completed. Keels have been laid on several of the ways and as soon as shipbuilding operations are in full swing a maximum of 9,500 men will be employed in the yard. On a single eight-hour shift about 6,500 men will be required; but as much of the work will be done in two shifts, with overtime keeping the plant in operation practically twenty-four hours a day, provision must be made for over 9,000 workers.

Satisfactory Progress

That such satisfactory progress has been made in the construction of this plant against unusual difficulties is attributed to the foresight and ability exercised by the Merchants Shipbuilding Corporation in so planning and coördinating the work that each part of the gigantic undertaking was brought to completion at the same time, thus providing a complete shipbuilding plant in working order before the actual operations of shipbuilding were begun. Under the leadership of the parent organization, the construction work was divided up and sub-let to separate contracting firms, each of which, with its own working staff and organization, was especially fitted and equipped to carry out efficiently the particular work assigned to it. Thus each part of the plant, as a unit, was rapidly pushed to completion without interference or delay from the other work.

The original contract for ships to be built at this plant called for forty single screw cargo vessels of 9,000 tons

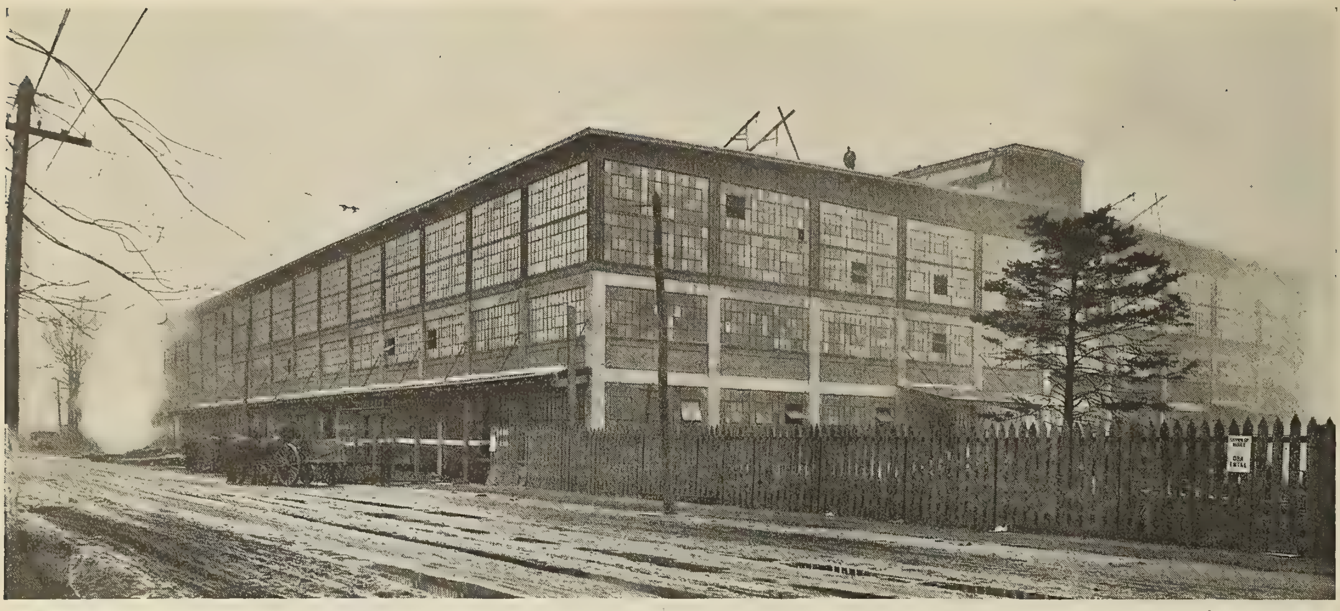

Fig. 2.—General Stores and Mold Loft Building Built in Forty Days

deadweight carrying capacity, each 401 feet long, 54 feet beam and 32 feet depth, fitted with geared turbine propelling machinery and watertube boilers of 3,000 horsepower, designed to give the vessels a sea speed of about 11 knots. Later, the contract was increased by the addition of twenty more vessels of the same size. From 12 to 20 percent of the hull work will be fabricated at the yard, while the remainder will be fabricated in the bridge and structural shops outside. It is estimated that the vessels will be about four months on the ways and one month at the fitting out berth.

The plant is divided into four yards, comprising the storage yards for fabricated and unfinished material, the building ways, shops and service buildings. Twelve shipways are provided in groups of four each. The ways are 484 feet long, spaced for the most part 108 feet between centers. At the water end they are supported for a length of about 174 feet up to high water level on wooden piles, the tide here being about 5 feet 9 inches. On shore the ways are of concrete construction throughout, the foundations consisting of concrete piles, from 15 to 35 feet long, capped with reinforced concrete cross beams. The declivity of the ways is 9/16 inch to the foot.

Shipways and Cranes

Between each set of ways is a steel crane runway, each runway carrying two traveling boom cranes for conveying the material onto the ways, as it is brought from the storage yards or fabricating shops to the head of the ways. Five of the runways, designed by Terry and Tench, are supported on triangular steel towers, footing on individual concrete bases resting on piles. The towers are

Fig. 3.—Plate and Furnace Shops

Fig. 4.—Typical Buildings in New Industrial Town

thoroughly braced both crosswise and longitudinally with struts. The other seven runways, are supported on square steel towers footing on spread concrete foundations and thoroughly braced.

The traveling boom cranes for these runways are of two types. The cranes used on nine of the runways have a capacity of 15 tons at a reach of 54 feet and 5 tons at 92 feet. The other cranes have a capacity of 16 tons at a reach of 54 feet.

At the shore end of each runway a building is provided for tools, paint, toilets and the transformers.

Storage Yards

Fabricated ship steel from outside shops is first brought on spur tracks from the main line of the Pennsylvania railroad to the main storage yard, located inshore from the shipways and beyond the plate and furnace shops, for sorting and distribution. Four railroad tracks in this yard are served by three A-frame gantry cranes, two of 10 tons capacity and one of 15 tons.

From the main storage yard, tracks lead to the head of the shipways, to the furnace and plate shops and to the fitting out yard. Along one side of the plate shop the tracks are served by two 10-ton A-frame gantry cranes.

At the fitting out wharf, which is located downstream from the shipways and which is of sufficient length for fitting out three vessels simultaneously, the river is being dredged to a depth of 20 feet. On a 30-foot gage track running along the water edge of the wharf is a 60-ton gantry crane, which, with the lighter locomotive cranes, will convey materials and equipment on board the vessels after launching.

Old Buildings Utilized

As the shipyard is erected on the site of the Standard Cast Iron Pipe and Foundry Company, which was purchased by the Merchants Shipbuilding Corporation less than a year ago, the buildings already standing, which are of substantial steel and brick construction, have been used so far as possible to house various departments of the shipbuilding company. The new buildings required have been made of permanent construction with steel or combined reinforced concrete and steel frames. The whole plant, in fact, including the shipways and shops, has been laid out and designed by the Merchants Shipbuilding Corporation, with a view to its permanent use as a modern, up to date shipbuilding establishment, irrespective of the present emergency needs.

In the old buildings have been located the main plate and furnace shops, the pipe, sheet metal and riggers' shop, the machine shop and boiler and blacksmith shops. The general stores and mold loft are housed in a new three-story building of reinforced concrete and steel frame construction, 300 by 200 feet, built complete in forty days, a record of which the contractors may justly feel proud. The shipwrights' shop and joiner shop are also new steel frame buildings, located near the fitting out wharf. Adjoining the buildings a paint shop and pipe storage building is provided.

The plate and furnace shops are in one building about

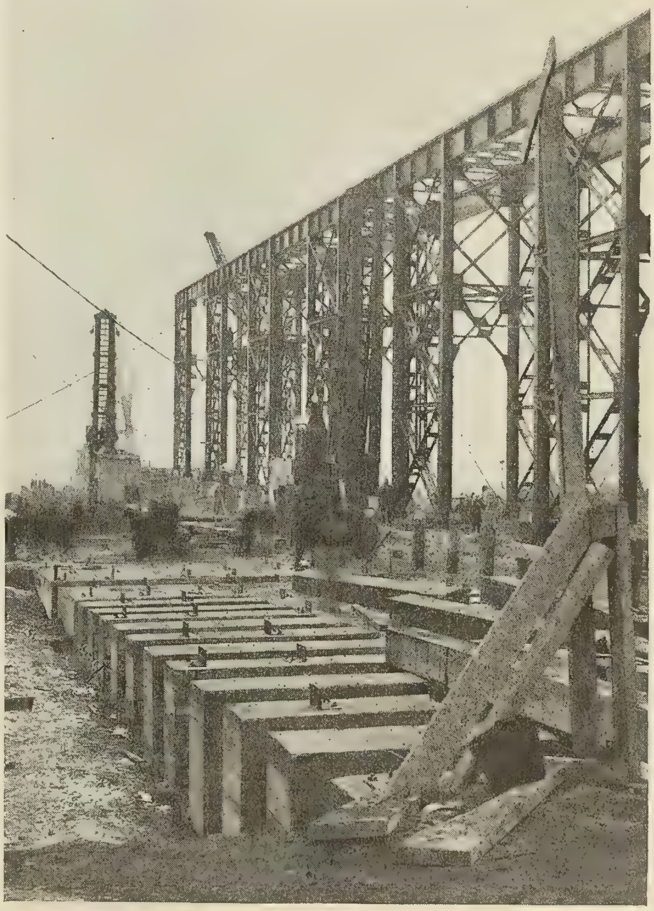

Fig. 5.—Showing Permanent Character of Concrete Foundation for Shipways

1,000 feet long and 102 feet 10 inches wide, made continuous by joining together two of the old buildings and rearranging the interior to accommodate the installation of the necessary machinery for the progressive handling and fabricating of ship steel. The plate shop itself is 459 feet 4 inches long, divided into two aisles 47 feet and 55 feet 10 inches wide respectively. It is of steel frame construction with brick and corrugated iron sides.

Equipment of Plate Shops

At one end of the plate shop is a laying out space with ten benches, each 27 by 6 feet. Opposite the laying out space, in the smaller aisle, is a set of mangling rolls. Adjacent to the laying out space in the larger aisle are six 48-inch punches, equipped with Lysholm spacing tables, while opposite in the smaller aisle are two 36-inch punches and a gate shear of the same make. Beyond the gate shear is a code punch, a manhole punch and rotary shear, and three 36-inch punches. At the extreme end of the shop is the tool room, next to which is a radial countersinking machine.

In the larger aisle along the wall beyond the punches are two 30-foot plate planers and three radial countersinking machines. Opposite the countersinking machines are a vertical shear, a plate punch, a scarphing machine and a set of 32-foot bending rolls.

Pipe and Riggers Shop

Another department housed in one of the old buildings is the pipe, sheet metal and riggers shop. This building is 182 feet 9 inches by 109 feet 6 inches, the floor space being divided up for sheet metal working, the electrical department, model and storage. The principal equipment here consists of pipe threading machines, all with direct motor drive. There are in all three 2-inch, two 4-inch, two 6-inch, one 8-inch and one 12-inch machines.

The equipment also includes four drill presses and a horizontal and a radial drill, a disk grinder and disk press, a metal band saw and an emery wheel grinder. The tool room is at one corner of the building.

Shipwrights and Joiner Shops

For the shipwrights' shop, a new steel frame building 165 feet and 6¾ inches by 87 feet 4 inches was put up, the building being completed on December 15. For equipment, the shop has a parallel swing saw, a No. 14 straight rip saw, band saw, single surfacer, planer, boring machine and two grinders.

The joiner and pattern shop, one of the largest of the new buildings at the fitting out wharf, is of steel frame construction 240 feet long by 75 feet wide. The tool room and office are on opposite corners at one end of the building. The machinery here includes a railway cut-off saw, single head tenoner, vertical hollow chisel mortiser, four-sided sticker, jointer, variety saw, universal saw and universal sandpaper machine. There are also two lathes and a swing cut-off table, a 36-inch band saw, a double spindle shaper and 48-inch triple drum sander, a parallel swing saw and a universal woodworking machine, grindstone, 12-inch circular saw, jointer, woodturning gap lathe, band saw and surface planer. The building was finished on November 29 and the machinery in by December 20.

In addition to the above named buildings there are at the main entrance to the yard the plant office building, the large administration building, time clock house, a garage, hospital and a large restaurant.

New Industrial Town Built

Not the least interesting feature of the work at the Bristol plant is the way in which the company is solving the problem presented by the lack of facilities for housing shipyard workmen in Bristol and neighboring towns. It was found necessary to provide homes for about 3,000 workmen and their families and for this purpose a new industrial town, adequate for housing a population of 6,000, is being erected on a site 2,400 by 1,200 feet, adjacent to the yard.

The town site is attractively laid out in city blocks with a playground and park in the center. The houses are arranged in groups comprising barracks for bachelor quarters with boarding houses or hotels at the ends of the blocks, apartment houses for small families, group houses for larger families, and finally 100 single houses for those who desire and can afford this mode of living. About 1,500 men can be accommodated in the barracks, 1,000 persons in the apartments, 1,500 in the group houses and 400 in the single houses. A central heating plant will take care of the barracks and those houses not provided with furnaces. Electric lighting will be supplied to every house and Bristol's water and sewage systems will be utilized.

The industrial houses as well as the new buildings in the shipyard were built by Fred T. Ley & Company, Inc., of New York and Springfield, Mass. The other contractors engaged in the building of the Bristol plant were as follows: John Monks & Sons, New York, shipways and craneway foundations, including outboard piling, also pier and bulkhead construction; William Gordon Corporation, New York and Philadelphia, installation of power plant equipment, machinery, pipe lines, electrical and mechanical equipment; Raymond Concrete Pile Company, concrete piling; Leverring & Garrigues, furnishing and erection of structural steel on buildings; American Dredging Company, dredging; Alphons Custodis Company, labor. The plant was built under the supervision of Robert E. Kline, plant engineer of the Emergency Fleet Corporation, and under the direction of W. H. Mason, superintendent of construction of the Merchants Shipbuilding Corporation.

When wood alcohol is to be used to any extent, have the room very well ventilated, as it affects the eyes and even produces blindness.

In experimental work it is not wise to make two changes at the same time, as, if the result is satisfactory or unsatisfactory, the reason for either is still obscure.

Area and surface are not synonymous, and sometimes men mix them up as did the man who corrugated a piston, thinking that in so doing he was increasing area and making his engine more powerful.

The continuous rotary motion of the turbine is ideal for certain drives, but the crank is still the ideal drive for an air compressor, as it gives the mechanical advantage of power application just when it is needed.

It is very advisable to have more than one way of getting out of a boiler or engine room, even if one of them is not very handy.

It is astonishing to see how few engineers understand how a steam steering engine works. He can tell you perhaps why it starts but he does not know why it stops.

Builders of the Emergency Fleet

THE United States Shipping Board Emergency Fleet Corporation has made public a list of the shipbuilders engaged in building vessels for the new American merchant marine. This list comprises 133 yards, 58 of which are building steel vessels, 69 wooden vessels, 5 composite vessels, and one concrete ships.

A summary of the classification is given in the following table:

Location of Shipyards	Builders of Steel Vessels	Builders of Wood Vessels	Builders of Composite Vessels	Builders of Concrete Vessels	Builders of Requisitioned Vessels (steel)
Atlantic Coast	18	44	4	1	15
Pacific Coast	11	24	1	0	7
Great Lakes	2	1	0	0	5
Totals	31	69	5	1	27

The complete list of the companies engaged in building merchant vessels, giving the location of the offices and works, is as follows:

Builders of Steel Vessels

American International Corporation, 140 North Broad street, Philadelphia, Pa. (Works, Hog Island, Philadelphia, Pa.)
The Atlantic Corporation, 77 Franklin Street, Boston, Mass. (Works, Porthsmouth, N. H.)
The American Shipbuilding Company, Cleveland, Ohio.
American Shipbuilding Corporation, Alexandria, Va.
Baltimore Dry Dock & Shipbuilding Company, Baltimore, Md.
Bayles Shipyard (Inc.), 115 Broadway, New York. (Works, Port Jefferson, L. I.)
California Shipbuilding Company, Long Beach, Cal.
Columbia River Shipbuilding Corporation, Portland Ore.
Downey Shipbuilding Corporation, 120 Broadway, New York. (Works, Richmond Borough, New York.)
Daniels, Oscar, Company, Woolworth Building, New York. (Works, Tampa, Fla.)
Erickson Engineering Company, Hanover National Bank Building, New York. (Works, Seattle, Wash.)
Federal Shipbuilding Company, 54 Dey street, New York. (Works, Hackensack River, N. J.)
Groton Iron Works, 50 Broad street, New York. (Works, Groton, Conn.)
Hampton Roads Shipbuilding & Dry Dock Corporation, Norfolk, Va.
Jahncke Shipbuilding Company, 814 Howard avenue, New Orleans, La.
Los Angeles Shipbuilding & Dry Dock Company, Los Angeles, Cal.
Merrill-Stevens Shipbuilding Corporation, Jacksonville, Fla.
Moore & Scott Iron Works, San Francisco, Cal. (Works, Oakland, Cal.)
Merchant Shipbuilding Corporation, 165 Broadway, New York. (Works, Bristol, Pa.)
Newburgh Shipyards, Newburgh, N. Y.
Northwest Steel Company, Portland, Ore.
Patterson-McDonald Shipbuilding Company, Seattle, Wash.
Pacific Coast Shipbuilding Company, First National Bank Building, San Francisco, Cal. (Works, Suisun Bay, San Francisco.)
Pensacola Shipbuilding Company, 155 North Clark street, Chicago, Ill. (Works, Pensacola, Fla.)
Skinner & Eddy Corporation, Seattle, Wash.
Seattle Construction & Dry Dock Company, Seattle, Wash.
Southern Shipbuilding Corporation, Charleston, S. C.
Sun Shipbuilding Company, 1428 South Penn Square, Philadelphia, Pa. (Works, Chester, Pa.)
Saginaw Shipbuilding Company, Saginaw, Mich.
Submarine Boat Corporation, 5 Nassau street, New York. (Works, Newark, N. J.)
Western Pipe & Steel Company of California, San Francisco, Cal.

Builders of Wood Vessels

Alabama Dry Dock & Shipbuilding Company, Mobile, Ala.
American Shipbuilding Company, 11 Broadway, New York. (Works, Brunswick, Ga.)
Beaumont Shipbuilding & Dry Dock Company, Beaumont, Tex.
Barbare Brothers, Tacoma, Wash.
Venicia Shipbuilding Corporation, 131 Loidesdorff street, San Francisco, Cal. (Works, Benicia, Cal.)
Coast Shipbuilding Company, 504 Concord Building, Portland, Ore.
Cumberland Shipbuilding Company, Portland, Maine. (Works, South Portland, Maine.)
Coos Bay Shipbuilding Company, Marshfield, Ore.
Chandler, R. J., Los Angeles, Cal. (Works, Wilmington, Los Angeles, Cal.)
Dantzler Shipbuilding & Dry Dock Company, Moss Point, Miss.
Dierks-Blodgett Shipbuilding Company, care of Dierks Lumber & Coal Company, Kansas City, Mo. (Works, Pascagoula, Miss.)
Feeney & Bremer Company, Tillamook, Ore.
The Foundation Company, Woolworth Building, New York. (Works, Passaic River, N. J.)
Fulton Shipbuilding Company, Los Angeles, Cal. (Works, Wilmington, Cal.)
Freeport Shipbuilding Company, Freeport, Me. (Works, South Freeport, Me.)
Grays Harbor M. S. Corporation, Aberdeen, Wash. (Works, Grays Harbor, Wash.)
Groton Iron Works, 50 Broad street, New York. (Works, Noank, Conn.)
Grant-Smith-Porter-Guthrie Company, St. Johns, Portland, Ore.
Gildersleeve Ship Construction Company, Gildersleeve, Conn.
Geo. A. Gilchrist, Thomaston, Me.
Hillyer-Sperring-Dunn Company, Jacksonville, Fla.
Hammond Lumber Company, San Francisco, Cal. (Works, Humboldt Bay, Cal.)
Hodge Ship Company, Moss Point, Miss.
Housatonic Shipbuilding Company, Stratford, Conn.
Heldenfels Brothers, Beeville, Tex. (Works, near Port Aransas, Tex.)
Jahnecke Shipbuilding Company, New Orleans, La. (Works, Tchefuncta River, La.)
Johnson Shipyards Corporation, Mariners' Harbor, Staten Island, N. Y.
Kingston Shipbuilding Company, Kingston, N. Y.
Kruse & Banks Shipbuilding Company, North Bend, Ore.
The Kelly-Spear Company, Bath, Me.
Lake & Ocean Navigation Company, 208 South La Salle street, Chicago, Ill. (Works, Sturgeon Bay, Wis.)
Lone Star Shipbuilding Company, 111 Broadway, New York. (Works, Beaumont, Tex.)
Maryland Shipbuilding Company, Lexington Building, Baltimore, Md. (Works, Seller's Point, Md.)
McBride & Law, Beaumont, Tex.
J. N. McCammon, Houston, Tex. (Works, Beaumont, Tex.)

Murnan Shipbuilding Corporation, Commercial Trust Building, Philadelphia, Pa. (Works, Pinto Island, Mobile, Ala.)
Midland Bridge Company, Houston, Tex.
J. M. Murdock, Jacksonville, Fla.
Morey & Thomas, Box 619, Jacksonville, Fla. (Works, St. Johns River, Jacksonville, Fla.)
Meacham & Babcock Shipbuilding Company, Seattle, Wash. (Works, Salmon Bay, Wash.)
McEachern Ship Co., Portland, Ore. (Works, Astoria, Ore.)
Newcomb Lifeboat Company, Hampton, Va.
National Shipbuilding Company, 120 Broadway, New York. (Works, Orange, Tex.)
North Carolina Shipbuilding Company, Morehead City, N. C.
Nilson & Kelez Shipbuilding Corporation, Seattle, Wash.
Peninsula Shipbuilding Company, Portland, Ore.
Portland Ship Ceiling Company, Portland, Me.
Potomac Shipbuilding Company, Colorado Building, Washington. (Works, Quantico, Va.)
Rodgers, Geo. F., & Company, Astoria, Ore.
G. M. Standifer Construction Corporation, Portland, Ore.
Sloan Shipyards Corporation, Olympia, Wash.
Sanderson & Porter, 52 William street, New York. (Works, Willapa Harbor, Wash.)
Ship Construction & Trading Company, 50 Broadway, New York. (Works, Stonington, Conn.)
Henry Smith & Sons Company, Baltimore, Md.
Southern Dry Dock & Shipbuilding Company, Orange, Tex.
L. H. Shattuck, Manchester, N. H. (Works, Portsmouth, N. H.)
Sommarstrom Shipbuilding Company, care of Maj. C. L. Tilden, 217 Front street, San Francisco, Cal. (Works, Columbia City, Ore.)
Seaborn Shipyards Company, Seattle, Wash. (Works, Tacoma, Wash.)
St. Helens Shipbuilding Company, San Francisco, Cal. (Works, St. Helens, Ore.)
Sandy Point Shipbuilding Corporation, Sandy Point, Me.
Tacoma Shipbuilding Company, Tacoma, Wash.
Traylor Shipbuilding Corporation, Cornwells Heights, Pa.
Tampa Dock Company, Tampa, Fla.
Universal Shipbuilding Company, National Bank Building, Houston, Tex. (Works, Houston Ship Canal, Harris County, Tex.)
Union Bridge & Construction Company, Morgan City, La.
U. S. Maritime Corporation, Union Savings Bank Building, Washington. (Works, Brunswick, Ga.)
Wilson Shipbuilding Company, Astoria, Ore.
Wright's Shipyards, Tacoma, Wash.
York River Shipbuilding Corporation, West Point, Va.

BUILDERS OF COMPOSITE VESSELS

Mobile Shipbuilding Company, Mobile, Ala.
Kelly Atkinson Construction Company, Security Building, Chicago, Ill. (Works, Mobile, Ala.)
Merrill-Stevens Company, Jacksonville, Fla.
Supple & Ballin, Portland, Ore.
Terry Shipbuilding Corporation, Savanna, Ga.

BUILDERS OF CONCRETE VESSELS

Liberty Shipbuilding Company, 515 State street, Boston, Mass.

YARDS BUILDING REQUISITIONED SHIPS

Albina Engine & Machine Works, Portland, Ore.
Ames Shipbuilding & Dry Dock Company, Seattle, Wash.
Cramp, William & Sons; Ship & Engine Building Company, Philadelphia, Pa.
Chester Shipbuilding Company, Finance Building, Philadelphia, Pa. (Works, Chester, Pa.)
Craig Shipbuilding Company, Long Beach, Cal.
Duthie, J. F., & Company, Seattle, Wash.
Fore River Shipbuilding Corporation, Quincy, Mass.
Great Lakes Engineering Works, Detroit, Mich.
Globe Shipbuilding Company, Superior, Wis.
Hanlon Dry Dock & Shipbuilding Company, Oakland, Cal.
Harlan & Hollingsworth Corporation, Wilmington, Del.
Manitowoc Shipbuilding Company, Manitowoc, Wis.
Moore, Samuel L., & Sons, Corporation, Elizabeth, N. J.
McDougall-Duluth Company, Duluth, Minn.
Newport News Shipbuilding & Dry Dock Company, Newport News, Va.
New York Shipbuilding Corporation, Camden, N. J.
New Jersey Shipbuilding Company, Land Title Building, Philadelphia, Pa. (Works, Gloucester, N. J.)
Pennsylvania Shipbuilding Company, Land Title Building, Philadelphia, Pa. (Works, Gloucester, N. J.)
Pusey & Jones Company, Wilmington, Del.
Standard Shipbuilding Company, 44 Whitehall street, New York.
Staten Island Shipbuilding Company, Port Richmond, N. Y.
Texas Steamship Company, Bath, Me.
Toledo Shipbuilding Company, Toledo, Ohio.
Tampa Shipbuilding Company, Tampa, Fla.
Union Iron Works, San Francisco, Cal.
Willamette Iron & Steel Works & Northwest Steel Company, Portland, Ore.
Bethlehem Steel Corporation, South Bethlehem, Pa. (Works, Sparrows Point, Md.; Quincy, Mass.; Wilmington, Del.; Elizabeth, N. J.; San Francisco, Cal.)

How to Make a Stud Setter

BY W. D. FORBES

Stud setters save time. It is exasperating to see a man screw down a stud and then caliper its height by trying to peek over the end of it.

How do you make a stud setter? Cut off a piece of tool steel to a length of about 2½ diameters of the stud that you are going to set. This may be either square or hexagonal, measuring across the flats a ¼ inch more than the diameter of the stud. Anneal this piece and drill and tap it straight through, tapping it as free as possible.

Take a flat pointed set screw of the diameter of the stud, and screw on to it a semi-finished nut until it comes up against the head of the screw. Have this set screw project from the nut into the tapped square hexagon, so that it will allow a stud to be screwed into it 1½ diameters before fetching up. This set screw is of course hardened.

Screw the set screw down until the nut stops on the tapped piece, start the stud to be set as usual and screw the stud setter on to it. When the top of the stud comes against the end of the set screw, a wrench can be used to screw down as far as required. By loosening up the set screw, the setter can be easily unscrewed.

How, it may be asked, will this give an even height of stud? Without something else being used, it will not, and that something else should be a piece of ordinary pipe of the size which will allow it to be slipped over the stud loosely and of a depth which, added to the length of the stud in the stud setter, will give the proper height of the stud. Coming down on this piece of pipe, if the set screw has been brought down to the nut again, will do the trick.

Vessels Requisitioned or Under Contract for United States Shipping Board

Classified List of Ships Under Construction for the Emergency Fleet, Showing Number, Type and Tonnage

THE United States Shipping Board authorizes publication of the following table showing the number, type and tonnage of the vessels which have been requisitioned or are under contract for construction in new or old established American shipyards for the American merchant marine:

NUMBER, TYPE, AND DEADWEIGHT TONNAGE OF VESSELS UNDER CONTRACT OR REQUISITIONED BY THE EMERGENCY FLEET CORPORATION, SEGREGATED AS TO WOOD, STEEL, COMPOSITE, AND CONCRETE.

Type of Vessels.	Vessels Under Contract.									
	Total.		Wood.		Steel.		Composite.		Concrete.	
	No. of Vessels.	Deadweight Tonnage.	No. of Vessels.	Deadweight Tonnage.	No. of Vessels.	Deadweight Tonnage.	No. of Vessels.	Deadweight Tonnage.	No. of Vessels.	Deadweight Tonnage.
Cargo:										
2,500	1	2,500	1	2,500	....	......	....	......	....	......
3,000	1	3,000	....	......	....	......	....	......	1	3,000
3,500	457	1,599,500	381	1,333,500	24	84,000	50	175,000	2	7,000
4,000 and under	37	147,650	29	115,650	....	......	8	32,000	....	......
4,500 and under	6	27,000	6	27,000	....	......	....	......	....	......
4,700	12	56,400	12	56,400	....	......	....	......	....	......
5,000 and under	220	1,022,700	....	......	220	1,022,700	....	......	....	......
6,000 and under	13	74,100	....	......	13	74,100	....	......	....	......
7,500 and under	76	569,600	....	......	76	569,600	....	......	....	......
8,800 and under	98	862,400	....	......	98	862,400	....	......	....	......
9,000	80	720,000	....	......	80	720,000	....	......	....	......
10,000 and under	86	814,800	....	......	86	814,800	....	......	....	......
12,000 and under	16	170,900	....	......	16	170,900	....	......	....	......
Total	1,103	6,070,550	429	1,535,050	613	4,318,500	58	207,000	3	10,000
Cargo and transports:										
8,000	70	560,000	....	......	70	560,000	....	......	....	......
10,000	5	50,000	....	......	5	50,000	....	......	....	......
Total	75	610,000	....	......	75	610,000	....	......	....	......
Tankers:										
7,500	3	22,500	....	......	3	22,500	....	......	3	......
10,000 and under	9	87,300	....	......	9	87,300	....	......	....	......
10,100	15	151,500	....	......	15	151,500	....	......	....	......
Total	27	261,300	....	......	27	261,300	....	......	....	......
Tug boats	20	......	14	......	6	......	....	......	....	......
Grand total	1,225	6,941,850	443	1,535,050	721	5,189,800	58	207,000	3	10,000
Grand total requisitioned and under contract	1,557	9,260,017	443	1,535,050	1,053	7,507,967	58	207,000	3	10,000

Type of Vessels.	Vessels Under Requisition.			
	Total.		Steel.	
	No. of Vessels.	Deadweight Tonnage.	No. of Vessels.	Deadweight Tonnage.
Colliers:				
5,000 and under	3	14,700	3	14,700
9,000 and under	4	34,400	4	34,400
Total	7	49,100	7	49,100
Passenger and cargo:				
5,000 and under	4	18,972	4	18,972
6,000 and under	2	10,600	2	10,600
Total	6	29,572	6	29,572
Tankers:				
5,000 and under	2	8,900	2	8,900
7,500 and under	7	49,300	7	49,300
8,800 and under	3	24,880	3	24,880
9,000 and under	7	63,000	7	63,000
10,000 and under	12	115,400	12	115,400
12,500 and under	15	161,295	15	161,295
12,650 and under	1	12,650	1	12,650
Total	47	435,425	47	435,425
Cargo:				
3,500 and under	82	267,280	82	267,280
5,000 and under	35	155,100	35	155,100
6,000 and under	2	11,000	2	11,000
7,500 and under	29	212,500	29	212,500
8,000 and under	2	16,000	2	16,000
8,800 and under	48	420,200	48	420,200
9,000 and under	14	126,000	14	126,000
10,600 and under	19	184,840	19	184,840
12,500 and under	24	286,450	24	286,450
15,000 and under	2	28,000	2	28,000
Total	257	1,707,370	257	1,707,370
Refrigerators:				
7,500 and under	12	77,700	12	77,700
10,000 and under	1	10,000	1	10,000
Total	13	87,700	13	87,700
Transports:				
5,000 and under	2	9,000	2	9,000
Grand total	332	2,318,167	332	2,318,167

REQUISITIONED VESSELS COMPLETED AND ACCEPTED OR RECONVEYED.

Type of Vessels.	Number of Vessels.	Deadweight Tonnage.
Colliers:		
8,600 tons	1	8,600
12,650 tons	1	12,650
Total	2	21,250
Ore carriers:		
6,000 tons	1	6,000
11,300 tons	4	45,200
17,060 tons	1	17,060
Total	6	68,260
Passenger and cargo:		
4,986 tons	1	4,986
Tankers:		
5,000 tons	1	5,000
8,500 tons and under	2	16,630
9,000 tons	2	18,000
Tankers—Continued.		
10,475 tons and under	4	41,725
14,900 tons and under	5	72,150
Total	14	153,505
Cargo:		
3,500 tons and under	26	82,520
4,500 tons and under	7	28,700
6,000 tons and under	4	22,500
7,500 tons and under	8	57,960
8,800 tons and under	14	123,200
10,000 tons and under	7	67,860
12,500 tons	3	37,500
13,000 tons	1	13,000
Total	70	433,240
Grand total	93	681,241

VESSELS CONTRACTED FOR AND REQUISITIONED.

Character of Vessels.	Number of Vessels.	Total Deadweight Capacity.
Wood	443	1,535,050
Steel	*723	5,207,400
Composite	58	207,000
Concrete	3	10,000
Total contracted	1,227	6,959,450
Total requisitioned (all steel)	†425	2,999,408
Grand total	1,652	9,958,858

*This total includes 2 vessels of 8,800 tons each, completed and accepted. †This total includes 93 vessels of 681,241 tons which have been completed and accepted or reconveyed to original owner. Prepared by the statistical department in the executive and administrative division. March 12, 1918.

Safety and Relief Valves

Discussion of Construction and Operation of Safety and Relief Valves for Marine Work

BY M. W. LINK*

SAFEGUARDING the various pressure vessels and lines in any power plant is a necessity. The various kinds of fluids, i. e., steam, air, hot water, cold water, oil, mixtures of steam and water and exhaust steam should be treated as an individual problem, so as to obtain the best results from the safety and relief valve. One type of safety valve is not adaptable to all of the above services.

First—Because steam and air are expansive fluids.

Second—Because water and oil cannot be treated as expansive fluids.

Huddling or Pop Chamber

The most important feature in any safety valve is the design of the disk and its huddling chamber.

Broadly speaking, a safety valve for an expansive fluid should have an adjustable pop or huddling chamber located between the valve seat and the atmosphere. Its fundamental principle is to give the valve a popping action; that is, when the valve relieves, the escaping steam is temporarily confined in this chamber before escaping to the atmosphere. This temporary confinement increases the upward load against the spring, thereby causing the disk to lift higher; and after a predetermined drop in pressure in the boiler, the valve closes with a slight snap.

The adjustable huddling chamber should be so designed that it is concentric with the disk in any position. The adjustable arrangement should be preferably located so as to be free from corrosion, scale, etc.

Safety or relief valves for cold liquids, oil, water, etc., do not require a huddling chamber of the same type as a steam pop valve, the energy of the moving liquid being utilized to assist the valve in lifting, and helps in reducing the drop in pressure before closure.

Many types of water relief valves do not have any huddling chamber, and, owing to their simplicity, are to be preferred to the more complex types. This type of valve loses considerable pressure before closing.

Safety valves for a mixture of steam and water—i. e., snifting and cylinder relief valves—require a different form of huddling chamber than one for steam or cold liquids. Usually, when these valves are called upon to act they must give quick, instant relief and handle a considerable volume of steam and water mixed.

Relief valves for hot water present a further problem. For pressures up to about 75 pounds one type of huddling chamber has been found to give best results. For pressures above 75 pounds an adjustable huddling chamber along lines of a steam pop valve will give best results.

In overhauling a steam pop valve the user should familiarize himself with the basic features of the huddling chamber design. This will save endless testing and trouble.

After assembling the valve, the huddling chamber ring or mechanism should be set to give the smallest possible loss in pressure or blow-down. The adjustment should then be adjusted to give 4 to 5 pounds blow-down on pressures between 100 and 200 pounds, and 6 to 8 pounds on higher pressures. Reducing the blow-down below the amounts mentioned invariably reduces the discharging capacity of the valve, and in the long run is wasteful of steam.

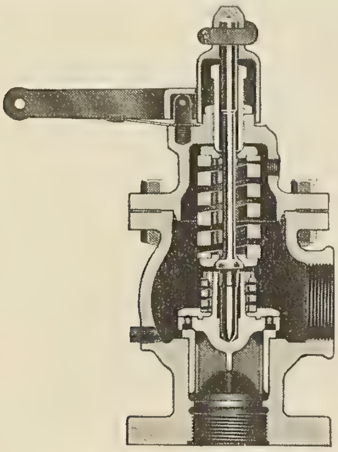

Fig. 1.—Valve with Inside Spring

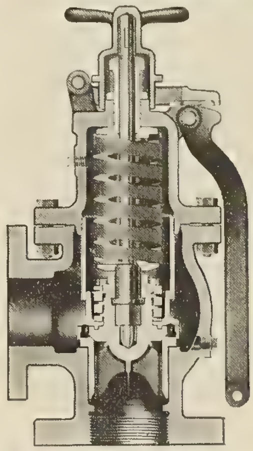

Fig. 2.—Valve with Inside Spring Encased

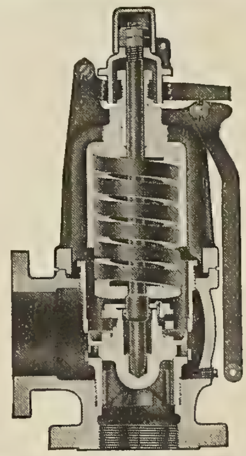

Fig. 3.—Valve with Outside Spring

Advocates of outside and inside springs on safety valves each have good reasons for their preference.

On steam pops, outside springs, generally speaking, are to be preferred. Springs exposed to the air remain cooler and are visible at all times. Some prefer inside springs because they are tamper-proof. Outside spring pops have a higher initial cost.

On compressed air pops, inside springs are as satisfactory as the outside type.

On water relief valves inside spring valves should be used wherever the *relieving and closing pressures are important* and must be maintained. Water relief valves with outside springs should be equipped with a stuffing box to prevent water from being thrown upward while the valve is discharging and overcome continual leakage if the valve outlet is piped to any line or vessel. Naturally, the tightness or friction created in the stuffing box will cause a variation in the action of the relief valve.

Cylinder relief valves should always have enclosed

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* Assistant mechanical expert, Crane Company, Chicago, Ill.

springs, as their action must not be interfered with, by friction or otherwise.

Relief valves for ammonia machines should naturally be of the enclosed type to prevent the escape of fumes to the atmosphere, and valves should be "All Iron" or steel.

Springs

Springs should be designed for the service they are to be used on. The length and number of free coils should be such that there is never any danger of the spring being compressed solid while the valve is discharging under over-pressure conditions, or while the valve is being opened by hand while under pressure. Springs for steam and hot water service should be capable of being compressed solid and should return to within .02 or .03 inch of their original length after compression.

The pitch diameter of the coils, if five times the diameter of the stock, is considered good proportions for steam pop valves. Extremely long springs have no particular advantage when used on safety valves. They look good on a drawing, but do not help the efficiency of a pop valve. After the valve has been set, any spring having sufficient clearance between the coils to allow a further compression equal to 10 percent of the diameter of the valve seat is long enough to give the best service, providing the pitch diameter is right.

Steel springs for steam should be drawn at a temperature of about 500 degrees F., and if possible 100 degrees higher. Before being used, the ends should be ground absolutely square with the center line of the spring. The writer conducted a series of tests upon springs not properly ground, and found the smooth action and clean-cut operation of a perfect safety valve was entirely ruined by springs ground 1/16 inch off square. The valves tested had swivel washers on both ends of the springs, but still the unequal downward thrust on the washer was evidenced in the action of the valve.

When overhauling a pop valve the spring should be thoroughly examined and ground square on the ends, removing any corrosion, etc. The spring washers should also be thoroughly cleaned, and all corrosion, scale and foreign matter removed.

Stems for Valves

Single-piece stems have been found to give the best service. Pop valves for steam, air, high pressure water should have a single stem extending from the disk to the outside of the valve bonnet.

Stems for steam pop valves should be of steel. While subject to corrosion, they do not wear at the point and are less subject to bending and crystallization. Brass stems are to be preferred on water relief valves because of their non-corrosive qualities. For marine use, manganese bronze will be found satisfactory.

One of the principal causes of erratic action in steam pop valves is bent stems. Any misalinement of the spring and any friction on the stem will cause a large blow-down and possibly a change in the popping pressure. The point of the stem in contact with the disk should be the rounded apex of a cone, which will give the best results in tightness, uniform popping and wear.

When overhauling a pop valve see that the stem is straight and the seating point is perfect. If battered or worn, dress it up.

Location of Seating Point on Stem

The design of the popping or huddling chamber governs the location of the end of the stem in the disk. It has been found that locating the end of the stem below the bearing on the seat a distance equal to one-quarter the diameter of the valve gives good results on many types of valves, although some types with the end of the stem above the seat bearing are giving good results. This is particularly true of flat seat safety valves. On water relief valves there is not much choice where the end of the stem meets the disk, although the lower the stem the longer the valve seems to keep tight in service.

Guiding Disk to Seat

Practically every successful make of safety and relief valve employs some type of integral guide which assists the disk in finding its seat. The multiple wing or feather guide is in the majority. Experience has proven this to be the best type of guide, suffering less from rapid wear than the single round or center guide. Some valves have three wings. The majority of types have four, and some have five. Service tests prove the five-swing guide superior for high pressure, high capacity steam pop valves.

Center pin guides are the most successful for use on oil, exhaust steam and water containing a large amount of scale-forming solids.

A good practice on steam valves is to have .01-inch clearance between the guides and bore of the valve bushing. Water and oil valves may have more clearance.

The bore of the valve bushing and the wing guides on the disk must have an absolutely smooth finish. "Any old kind" of finish is detrimental to the perfect operation of the valve, causing chattering, rapid wear and leakage.

In overhauling a pop or relief valve after having been in service, the guides and bore should be thoroughly cleaned and smooth. The smoother the better.

Relieving Capacity

The relieving capacity of safety valves, in pounds of steam, cubic feet of air and gallons of water per hour is a feature that has in the past not received the prominence it deserves.

It is a well-known fact that all pop safety valves of the same size but of different design do not have the same relieving capacity. This was illustrated by tests made by P. G. Darling, member A. S. M. E.; also by tests made by the writer, published in the *Valve World*, May, 1914.

The general results of both of these tests were the same; for instance, 4-inch pop safety valves of different designs at the same popping pressures, varied in relieving capacity 600 percent; that is, the lift of the disk varied from 3/100 inch to 18/100 inch. *The relieving capacity is directly proportional to the lift.*

This feature was recognized by the Master Mechanics' Association of the Railroads; also by the Boiler Code Committee of the A. S. M. E., in the formation of their National Boiler Code.

Water relief valves of the conventional type do not vary greatly in their relieving capacities, although some types, particularly those used on fire pumps, have very high capacities.

The Board of Supervising Inspectors recognize no fixed relieving capacities for safety valves.

Another important feature not universally known or taken advantage of is the enormous increase in relieving capacity due to a slight increase in overpressure while the valve is discharging. Presented below are two tables, Nos. 1 and 2, one showing the relieving capacity of pop safety valves on steam at the set pressure and at 3 percent overpressure. The lift of the disk at the set pressure 10/100 inch. The blow-down is 4 pounds below 200 pounds set pressure, 6 pounds above 200 pounds set pressure. The table on water relief valves is based on 10 percent over set pressure.

Broadside View of Concrete Ship *Faith* After Launching

TABLE No. 1.—STEAM, POUNDS DISCHARGED PER HOUR.

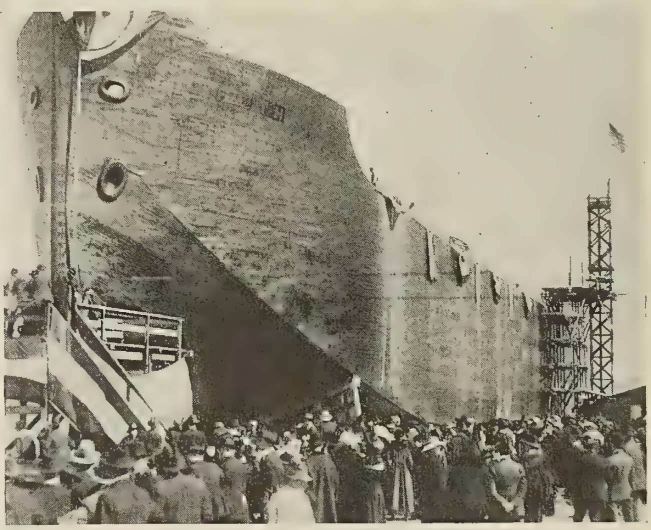
Size.		Boiler Pressures. 50 Pounds	100 Pounds	150 Pounds	200 Pounds	250 Pounds
1 inch	A	710	1,260	1,800	2,345	2,900
	B	850	1,510	2,160	2,815	3,480
1¼ inch	A	880	1,570	2,250	2,940	3,620
	B	1,055	1,885	2,700	3,425	4,345
1½ inch	A	1,060	1,885	2,710	3,530	4,350
	B	1,270	2,260	3,250	4,235	5,220
2 inch	A	1,420	2,510	3,595	4,710	5,800
	B	1,705	3,010	4,305	5,650	6,850
2½ inch	A	1,770	3,145	4,510	5,885	7,255
	B	2,125	3,775	5,410	7,060	8,705
3 inch	A	2,130	3,775	5,420	7,065	8,700
	B	2,550	4,530	6,500	8,480	10,440
3½ inch	A	2,480	4,400	6,325	8,240	10,160
	B	2,975	5,280	7,590	9,885	12,190
4 inch	A	2,840	5,030	7,230	9,420	11,610
	B	3,405	5,600	8,630	11,300	13,930
4½ inch	A	3,190	5,660	8,130	10,595	13,060
	B	3,820	6,790	9,750	12,705	15,670

A Represents capacity at set pressure.
B Represents capacity at 3 percent over pressure.

TABLE No. 2—GALLONS DISCHARGED PER MINUTE FROM COMMERCIAL WATER RELIEF VALVES AT 10 PERCENT OVER PRESSURE.
Sizes ¾ to 2 inches—BRASS. 2½ inches to 4½ inches—IRON BODY.

Size.	Set Pressures. 25 Pounds	50 Pounds	75 Pounds	100 Pounds	125 Pounds	150 Pounds	175 Pounds	200 Pounds
¾ inch	3.8	5.2	6.5	7.5	8.5	9.5	11	13
1 inch	5	7.5	9.5	11	13	15	18	21
1¼ inch	7	9.5	13	15	17	20	23	27
1½ inch	9	13	16	18	21	25	29	34
2 inch	13	17	21	25	30	35	40	48
2½ inch	50	68	86	100	116	140	160	195
3 inch	60	80	100	122	142	170	195	240
3½ inch	70	95	120	145	170	200	230	280
4 inch	80	100	135	165	195	225	265	320
4½ inch	95	125	155	185	220	255	295	360

In determining the proper size safety or relief valve to be used on any service it is well to use as small a valve as possible and take advantage of the increase in relieving capacity due to any slight over-pressure which may occur. This reduces initial cost, repair bills and increases the life of the valve.



Bow View of S. S. *Faith*

The smaller the valve the easier it is to keep it tight and the smaller the waste of steam, water or air.

(*To be concluded.*)

Launching of 5,000-Ton, Deadweight, Reinforced Concrete Ship *Faith*, at Redwood City, Cal., on March 14.
(For description see page 64, MARINE ENGINEERING, February, 1918)

Fig. 1.—Mold Loft, 500 Feet Long, in Second Story of Laying Out Building

Shipyard of the Sun Shipbuilding Company

Splendidly Arranged and Equipped Plant at Chester, Pa., for Building Standard Types of Oil Tankers and Steel Cargo Vessels

As a subsidiary of the Sun Company, Philadelphia, which has an oil pipe line terminus at Sabine Pass, Texas, and a refinery at Marcus Hook, Pa., and which maintains for the transportation of its products a fleet of ocean-going tankers with a combined tonnage of over 80,000, equivalent to a carrying capacity of 25,000,000 gallons of oil, the Sun Shipbuilding Company was formed about two years ago, for the purpose of building standard types of oil tankers and cargo vessels. The site chosen for the shipyard was on the Delaware river, at Chester, Pa., not far from the Sun Company's refinery. As the shipyard was designed to build only hulls and boilers, the extensive plant of the Robert Wetherill Company, engine builders at Chester, was purchased for the construction of engines and other machinery for the ships.

Sun Tanker Adopted as Standard

Specializing in the design and construction of standard types of oil tank and cargo vessels, the Sun Shipbuilding Company has spared no effort in producing economically the very best vessels that could be designed and built for the purpose. That the company has been eminently successful, although the yard has been in operation little more than a year, and its first vessel was launched last October, is shown by the fact that the company's design for a 10,000 ton deadweight oil tank steamship has been adopted by the United States Shipping Board as a standard.

The yard has a frontage of over 1,600 feet on the Delaware river, and extends back from the river about 1,500 feet, where the property is bounded by a branch of the Pennsylvania railroad.

General Arrangement of Plant

The plant is designed for a capacity of turning out 12 vessels a year and has five shipways, suitable for accommodating vessels up to 12,000 or 15,000 tons deadweight capacity. As shown by the plan of the yard, Fig. 9, at the head of the shipways are the main fabricating shops, back of which is the main storage yard. At one side of the shipways, and about 500 feet distant, is a wet dock, 200 feet wide by 600 feet long, which serves as a fitting out basis. At the head of the wet dock are the fitting out shops and general storehouse, and in back of that the boiler shop and blacksmith and light sheet metal-working shops.

The layout of the yard is such that as the material is received from the Pennsylvania railroad tracks at the inshore side of the property, it logically progresses from the storage yards through the laying out, fabricating and assembling shops to the head of the ways, where it is incorporated in the vessels under construction on the ways or goes through the fitting out shops to the wet dock and is there installed on the vessels after launching.

From the Pennsylvania tracks, a ladder of seven tracks runs through the plate and shape storage yard and into

Fig. 2.—Interior of Plate Shop, Showing Punches, Spacing Tables and Roller Skids

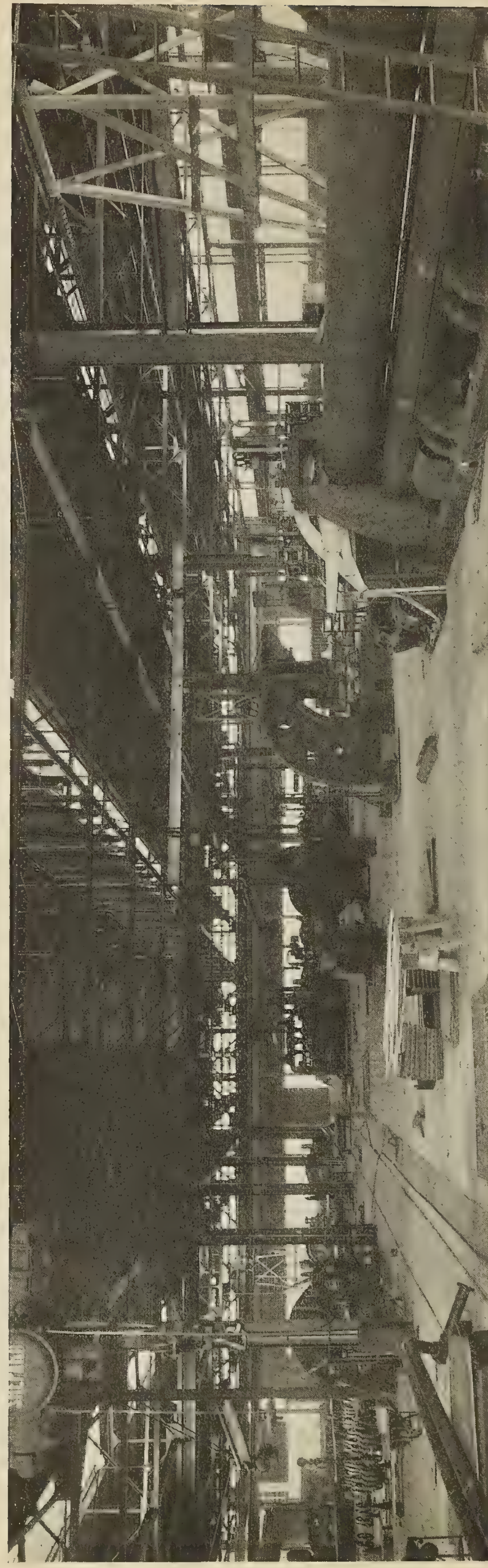


Fig. 3.—South End of Main Fabricating Shop. Five-ton Shepard Mono-rail Hoists Aid in Movement of Material Across the Shop

SHIPYARD OF THE SUN SHIPBUILDING COMPANY, CHESTER, PA.

Designed for Construction of Standard Type Oil Tankers and Cargo Vessels; Capacity, Twelve Ships a Year

Fig. 4.—General View of Sun Shipyard from Waterfront. Main Entrance and Office Building at the Left; Outfitting Shops, General Stores, Boiler Shop and Heating Plant in Center; Shipways and Fabricating Shops at the Right

Fig. 5.—View of Sun Shipyard from Top of Boiler Shop. Storage Yard at the Left; Fabricating Shops and Shipways in Center; Fitting Out Berth at the Right

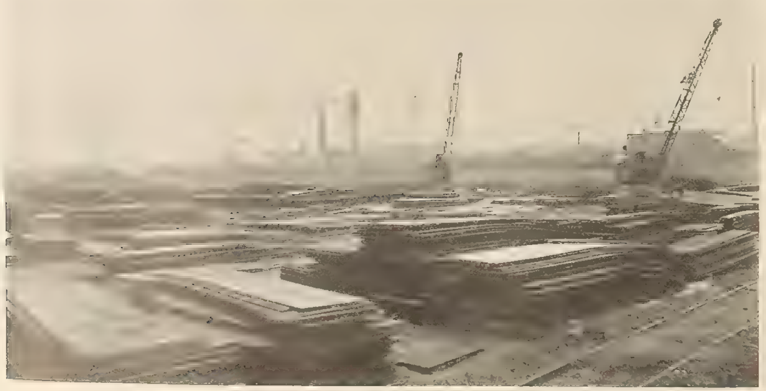


Fig. 6.—Plate Storage Yard, Showing Locomotive Cranes

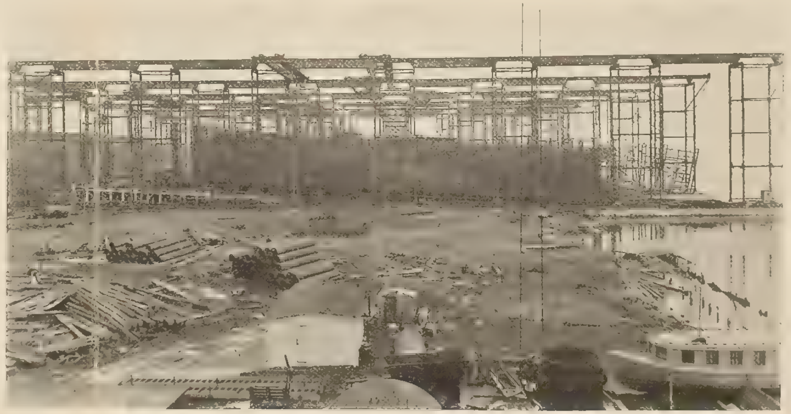


Fig. 7.—Shipways Built of Concrete and Served by Overhead Electric Traveling Cranes

Fig. 8.—Fitting Out Docks. Served by 120-Ton McMyler Hammerhead Crane

the laying out shop. In the yard, material is handled by locomotive cranes, but in the laying out and fabricating shops the material is handled on roller skids or by overhead electric cranes and hoists.

Over the laying out shop, which is 500 feet long by 80 feet wide, is the mold loft. At one end of the laying out shop is a set of Hilles & Jones straightening rolls, while in the center is a Williams, White & Company multiple punch. Two overhead Pawling & Harnischfeger electric traveling cranes of 5 tons capacity each traverse the length of this shop. At the far end of the shop is the hull smith shop, equipped with 30 forge fires, two oil furnaces, a Nazel hammer and Beaudry hammer.

Main Hull Fabricating Shop

Between the laying out and assembling buildings, but forming an integral unit with them, is the main fabricating shop for the ship plates and shapes. Here the arrangement of the machinery is such that the material, after being laid out, advances progressively through the different processes of punching, shearing, rolling, bending scarfing and straightening, until it arrives at the assembling shop, at the head of the ways, ready for riveting or immediate installation on the vessels under construction.

The fabricating shop is 230 feet wide by 300 feet long. At the upper end are four single-ended and three double-ended punches, all of Hilles & Jones make, equipped with

Fig. 10.—Main Office Building

Lysholm spacing tables, and also the plate and angle furnaces supplied by the American Shop Equipment Company. The plate furnace is 9 feet wide by 30 feet long and the angle furnace 4 feet wide by 52 feet long. At the bending blocks is a special flanging and beveling machine, designed and built at the Wetherill plant of the shipbuilding company. There is also, at the upper end

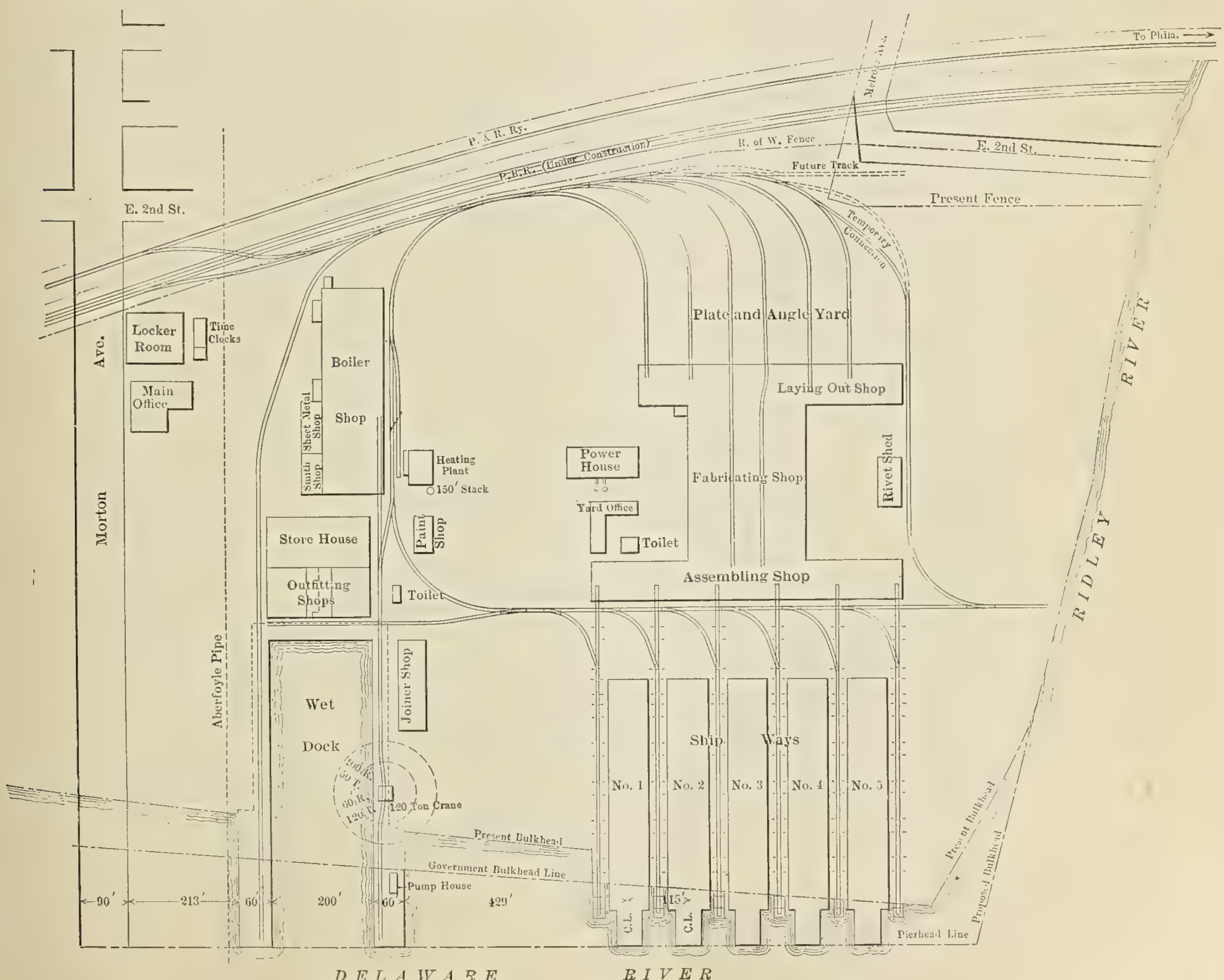


Fig. 9.—General Layout of the Yard, Showing Location of Buildings and Railroad Connections

Fig. 11.—Locker Building at Main Entrance

Fig. 12.—Interior of Employees' Locker Room

of the shop, a double angle shear and two single and one double-ended punches of the Hilles & Jones make, served with jib cranes. Alongside the bending slabs is an R. D. Wood joggler and along the east wall of the building, several rapid-action Hilles & Jones punches.

At the lower end of the fabricated shop are two Hilles & Jones 40-foot plate planers, a set of Hilles & Jones bending rolls, 37 feet long between housings, with the top roll 36 inches diameter and the bottom rolls 20 inches diameter, a set of straightening rolls, plate shears, man-

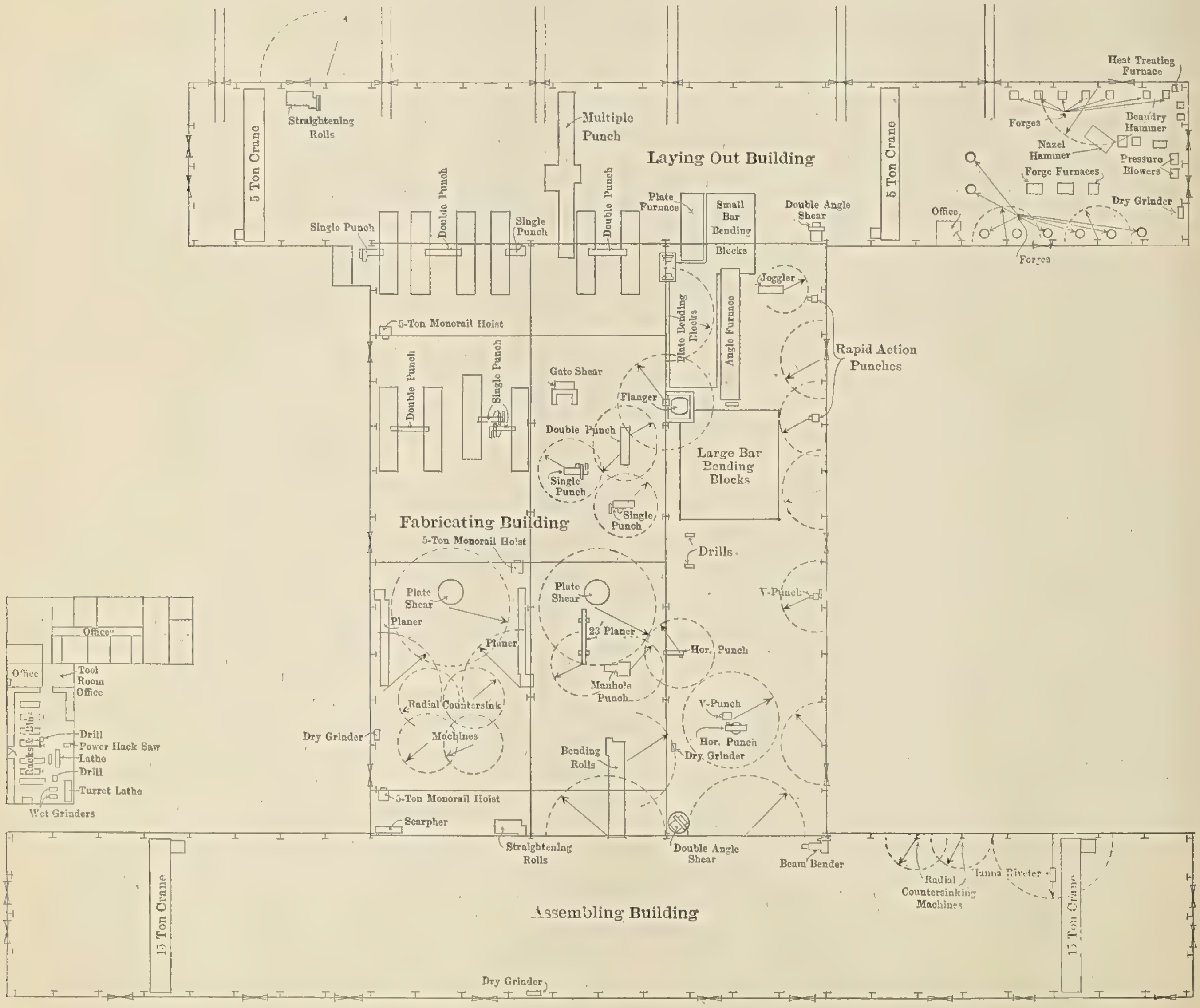


Fig. 13.—Plan of Main Fabricating Shops at Head of Shipways, Showing Location of Machinery

Fig. 14.—Wash Basins in Locker Room

hole punch and scarfing machine. The equipment also includes two horizontal and one vertical punch and four radial countersinking machines.

The assembling shop, which extends along the head of the shipways, and is joined to the fabricating shop, is 600 feet long by 80 feet wide, and is served by two overhead 15-ton Pawling & Harnischfeger traveling cranes. In the assembling shops, most of the operations are carried out with portable tools, such as pnuematic riveters and chipping hammers, and oxy-acetylene welding and cutting apparatus. At one end of the shop are a Hilles & Jones beam bender, two radial countersinking machines and a Hanna riveter.

Shipways

The shipways, of which there are five, are of reinforced concrete construction, 500 feet long by about 90 feet wide, spaced 115 feet between centers. The shipways are uncovered but are served by overhead electric traveling cranes, running on steel craneways, located between each shipway and extending up to the assembling shop. Over each shipway there is one 15-ton Pawling & Harnischfeger and one 10-ton Shaw crane.

Fig. 16.—120-Ton McMyler Hammerhead Crane at Fitting Out Dock

Fitting Out Berth

Downstream, about 500 feet from the shipways, is the wet dock, which is served by a hammerhead crane of 120 tons capacity at a 60-foot radius, built by the McMyler Interstate Company, Cleveland. Alongside the fitting out dock is a joiner and carpenter shop, and at the head of the dock, a pipe and coppersmith shop, equipment machine shop and riggers and electricians' workshop. The pipe and coppersmith shop is 75 feet by 90 feet. Its equipment includes 12-inch, 6-inch and 3-inch pipe threading and cutting machines, supplied by the Bignall & Keeler Machine Works, Edwardsville, Ill., a Lovekin tube expanding and

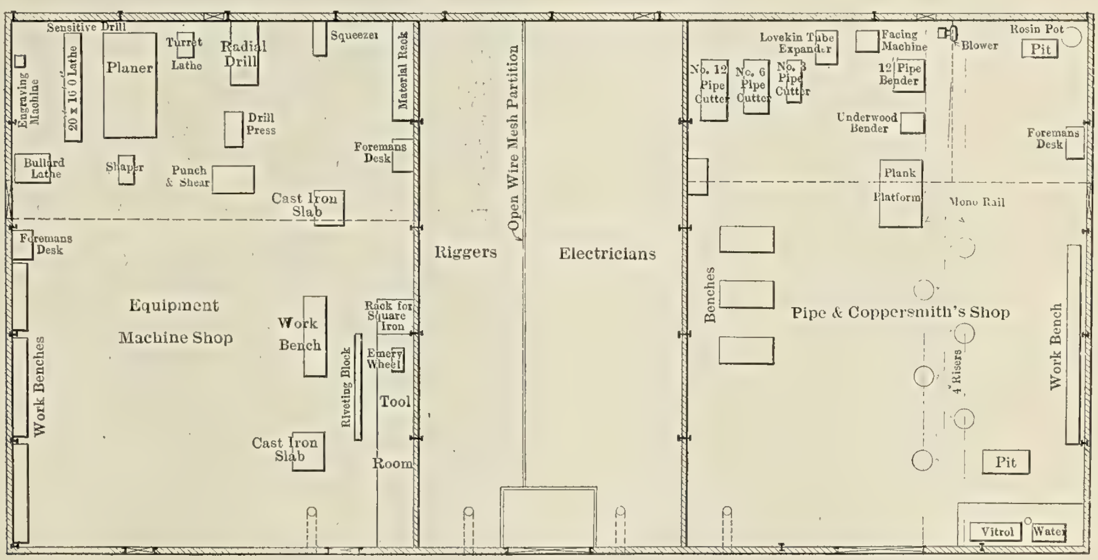


Fig. 15.—Plan of Fitting Out Shops at Head of Wet Dock

flanging machine; an R. D. Wood 35-ton hydraulic pipe bending machine and an Underwood pneumatic pipe bender, with a capacity for pipe up to 3-inch diameter.

The outfitting machine shop, which is used for making valves, flanges, ladders and other equipment for the vessels, is equipped with a Niles-Bement-Pond planer, 36 inches by 36 inches by 8 foot-travel; a Jones & Lamson turret lathe; a 24-inch Bullard vertical turret lathe; a 24-inch by 12-foot Lodge & Shipley lathe; two Hilles & Jones radial drills; two 5-foot Niles-Bement-Pond radial drills; a Shipley drill press and 24-inch Cincinnati drill press. There is also a Sellers combination punch and shear for use in making ladders and similar equipment; a Dallet horizontal drill press and a 30-ton hydraulic squeezer for bending angles, flat bars, etc., for floor plates and the like.

Adjoining the fitting out shops is the general storehouse, 200 feet long by 100 feet wide, on one side of which is a gallery partitioned off, so that the material and sup-

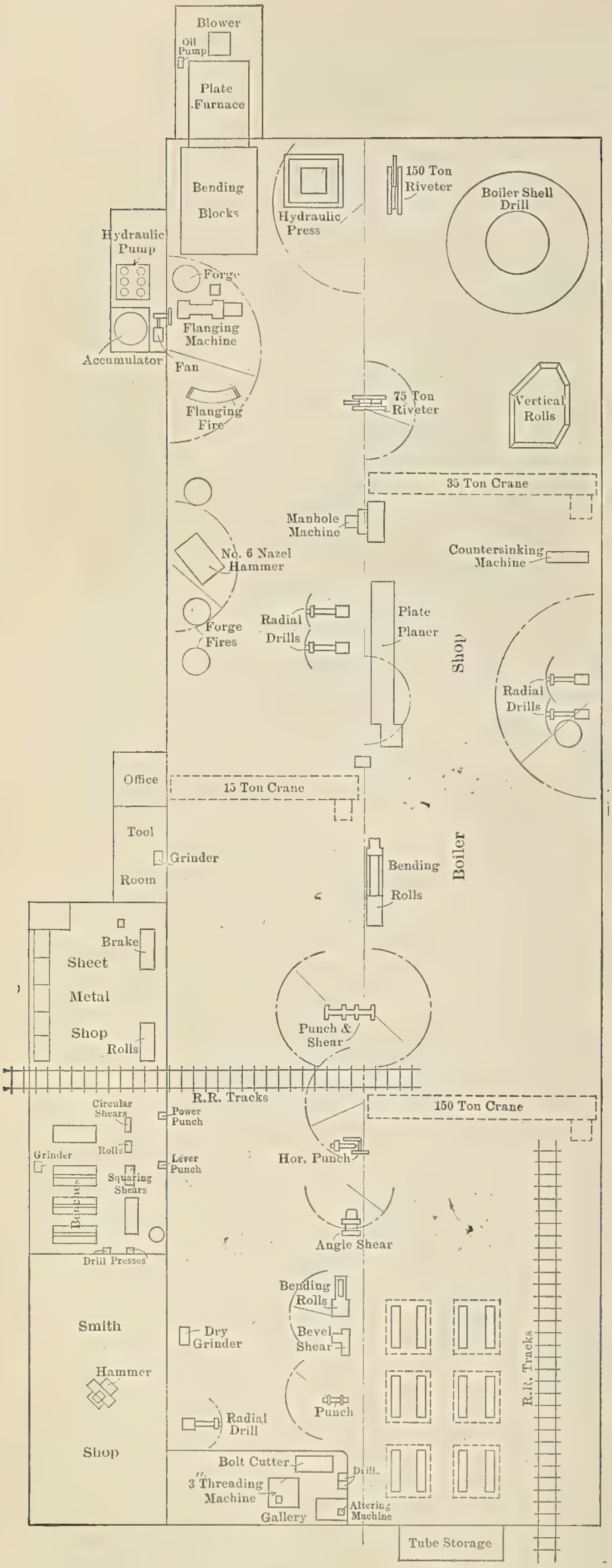


Fig. 17.—Plan of Boiler Shop

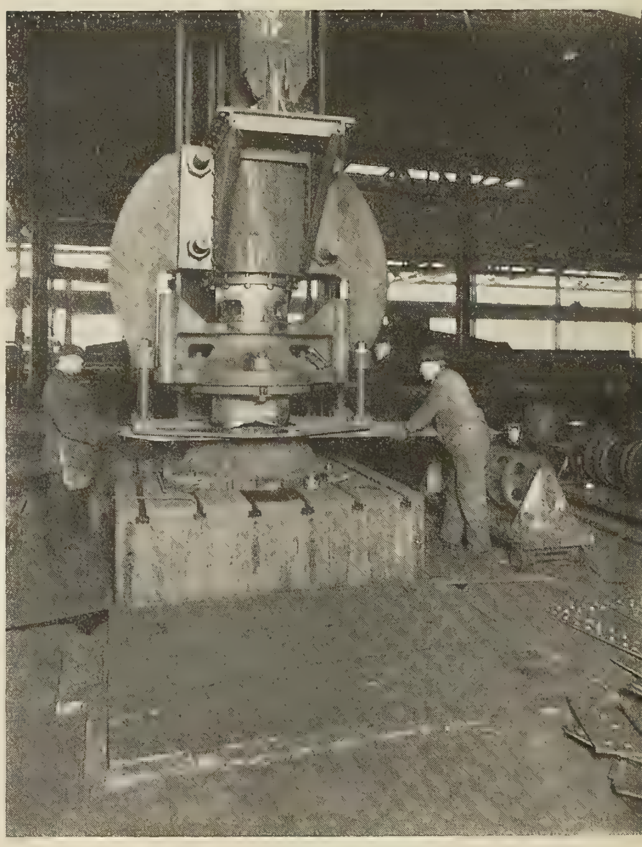


Fig. 18.—R. D. Wood Hydraulic Manhole Punch and Flanging Machine in Plate Shop

plies for each contract being executed in the yard can be kept separate from the general stores. On the floor, heavy equipment, such as deck machinery, etc., is stored, and metal racks and bins are provided for copper, brass and iron piping, cold-rolled iron bars, plates, fittings and small equipment. Entrances to the storeroom are inclosed with wire partitions and separate entrances are provided to each of the adjoining fitting out shops.

Boiler Shop

In the rear of the general storehouse is the boiler shop, 400 feet long by 120 feet wide. In the layout and equipment of the boiler shop, the various departments are so arranged and coördinated, that work can progress through the shop from the laying out of the plates to the testing of the finished boilers without delay or rehandling of materials from one end of the shop to the other. The material is received at one side of the shop in the center of the building, where it is laid out. Tack rivet holes are

Fig. 19.—150-Ton R. D. Wood Hydraulic Riveter in Boiler Shop; Gap, 14 Feet

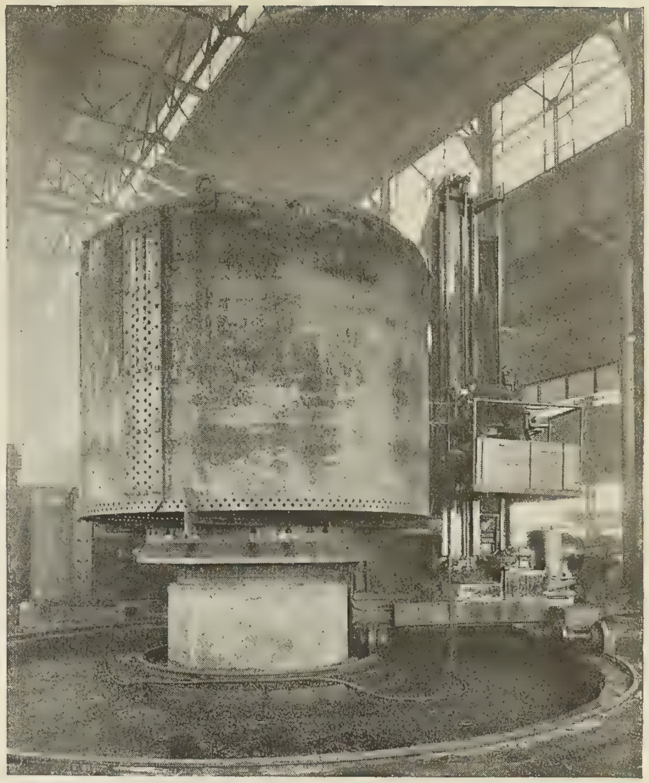


Fig. 21.—Three-Spindle Detrick & Harvey Boiler Shell Drill

drilled by radial drills next to the laying out space. Beside the radial drills is a Cleveland countersinking machine. The plates next go to a set of 14-foot vertical bending rolls, made by the Southwark Foundry & Machine Company, and pass from this to a three spindle boiler shell drill made by the Detrick & Harvey Machine Works of Baltimore. At the end of the shop is a 150-ton R. D. Wood hydraulic riveter with a 14-foot gap, alongside of which is a 100-ton hydraulic flanging press, built by the Wetherill Company. In the opposite corner of the shop is a 16-foot plate heating furnace, supplied by the American Equipment Company, and an R. D. Wood sectional flanging machine, together with forge and flanging fires and a Nazel hammer.

Fig. 20.—14-Foot Southwark Vertical Bending Rolls

Down the center of the shop there is a 75-ton 14-foot gap Niles-Bement-Pond hydraulic riveter and a manhole facing machine, also supplied by Niles-Bement-Pond Company. There is also a Hilles & Jones plate planer; a set of bending rolls and a combination Cleveland punch and shear. At the end of the large bay of the shop is the erecting and testing floor. At the corresponding end of the smaller bay are the lighter machine tools, including a horizontal punch, angle shear, small bending rolls and light punch, all supplied by Hilles & Jones; a Lennox beveling machine; a Landis machine for threading stay tubes and also a Landis triple machine for threading staybolts.

The boiler shop is divided into two bays, the larger bay being served by two Pawling & Harnischfeger overhead traveling cranes of 50 tons capacity each. For lifting the heaviest weights, such as finished boilers, these two cranes can be operated together, giving a lifting capacity of 100 tons. The smaller bay is served by one 15-ton and one 5-ton traveling crane of the same make.

Alongside the boiler shop is the light sheet metal shop, and blacksmith shop.

Power Plant

Power for the plant is taken from the Philadelphia Public Service Company, at 13,200 volts and transformed to 2,400 volts for use in the power house and 475 volts for the buildings. In the power house are two Ingersoll-

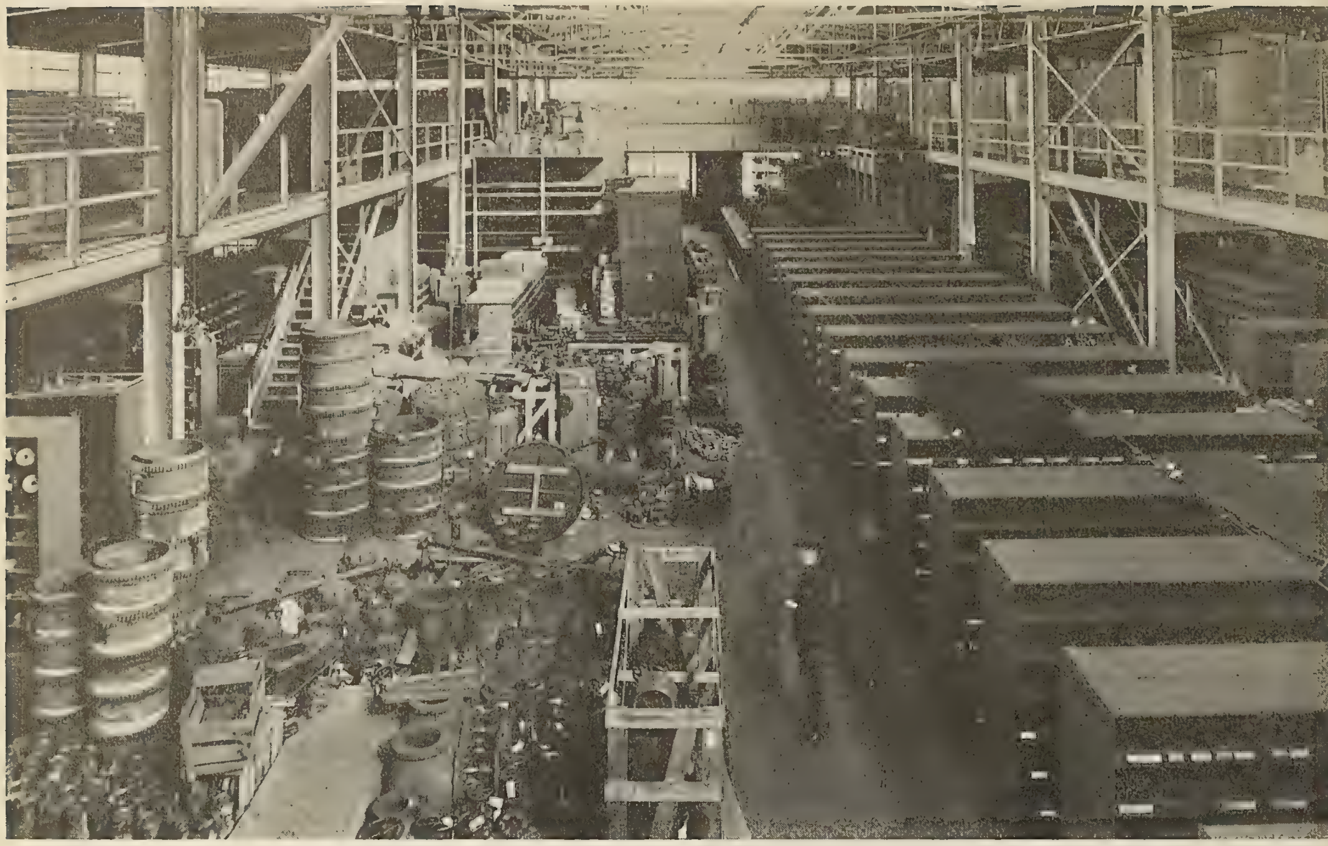


Fig. 22.—Interior of General Storehouse. Gallery at Right Partitioned Off into Compartments to Be Assigned to Each Vessel Under Construction

Fig. 23.—Interior View of Outfitting Machine Shop, Adjoining General Stores Building

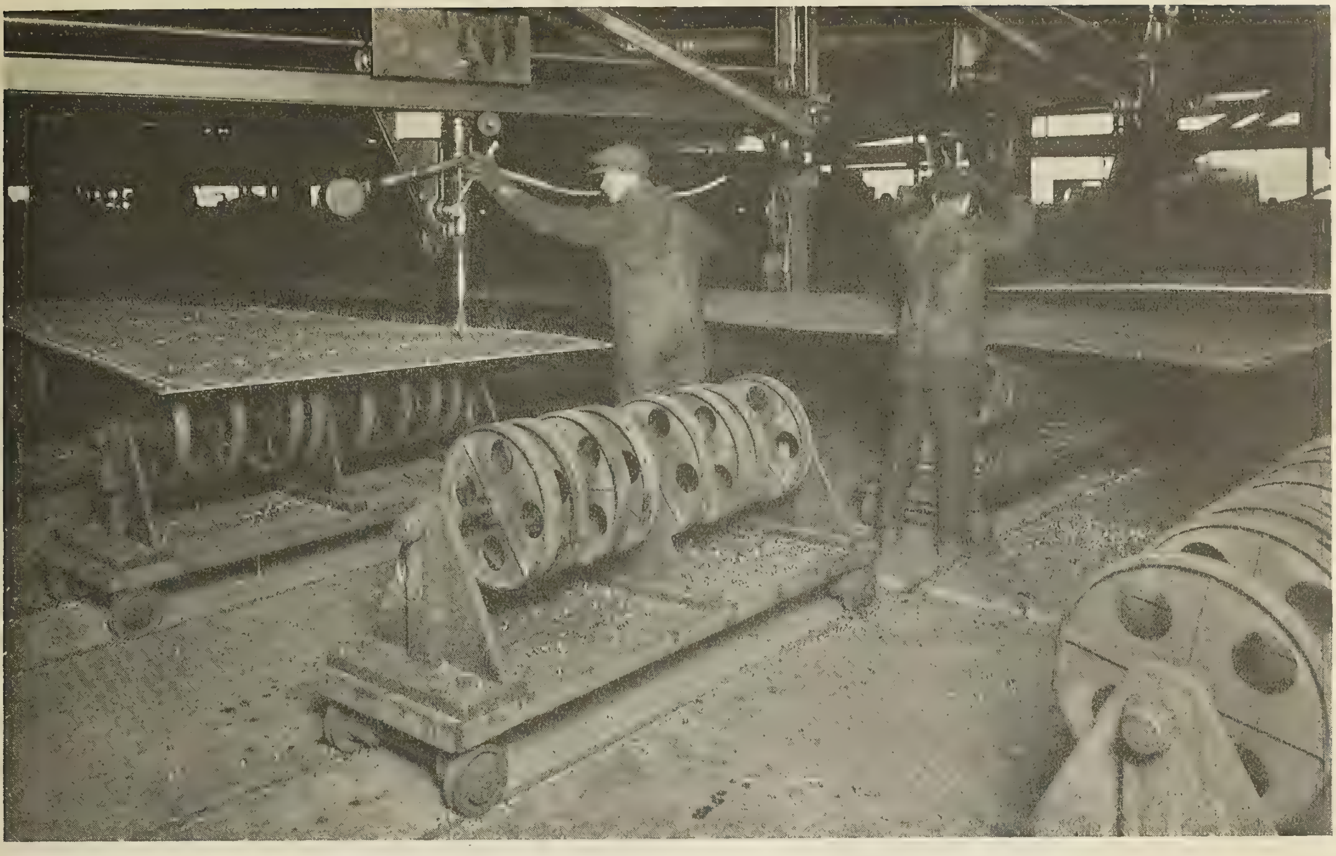


Fig. 24.—Radial Countersinking Machines in Plate Shop

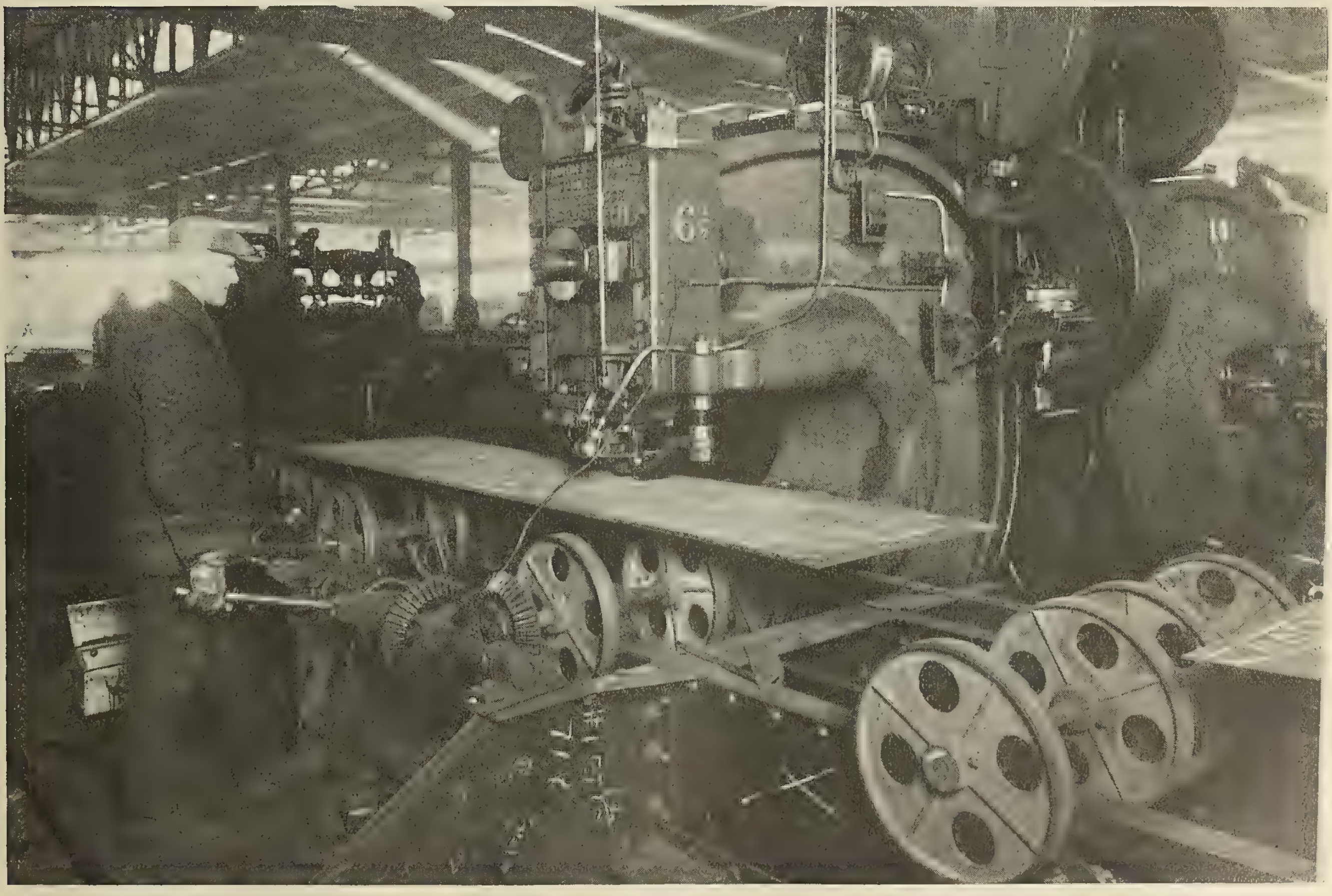


Fig. 25.—Hilles & Jones Punch in Plate Shop. Operator Is Handling Plate with Lysholm Spacing Table

Fig. 26.—Special Beveling and Flanging Machine at Angle Furnace

Fig. 27.—Plate Furnace (Plate and Angle Furnaces Supplied by American Shop Equipment Company)

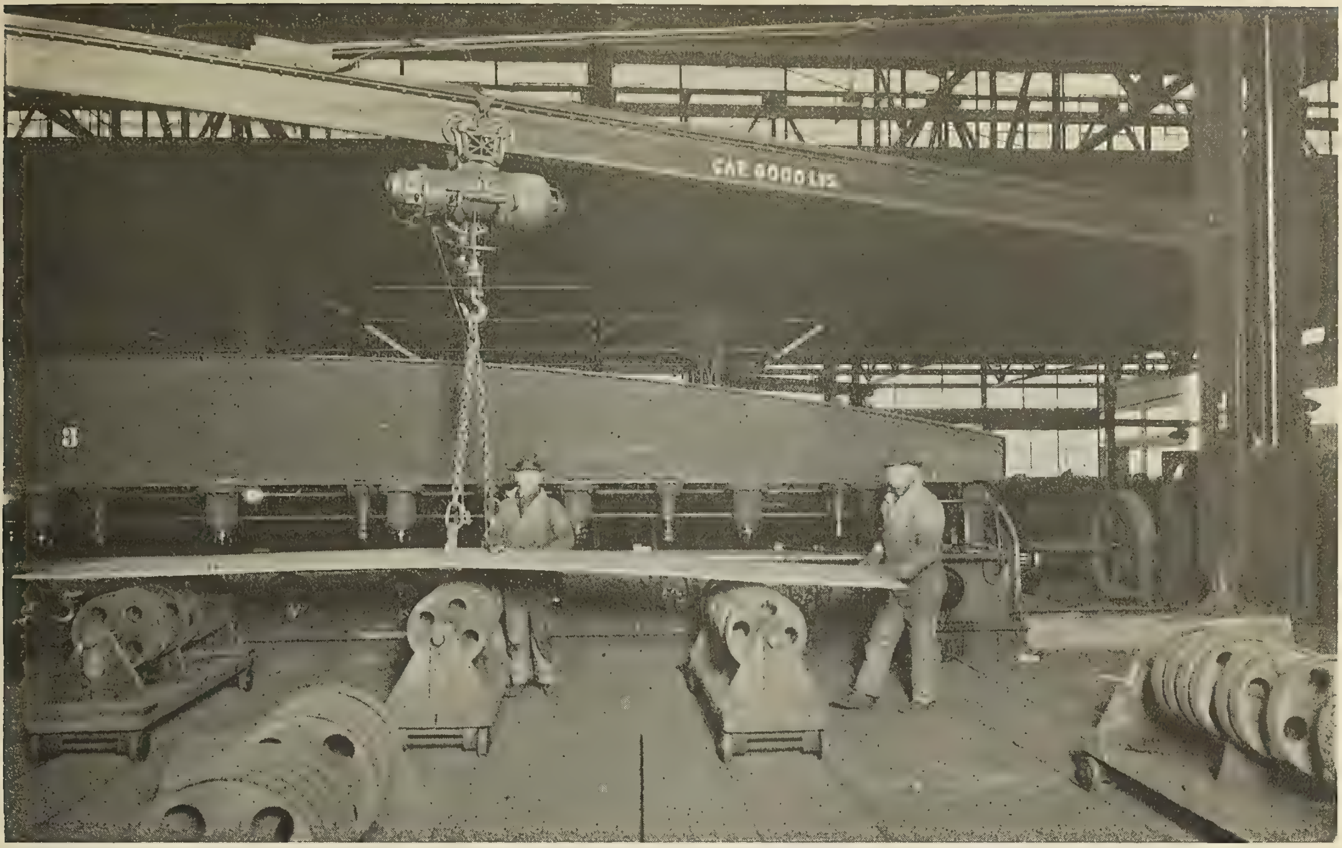


Fig. 28.—Shepard 3-Ton Electric Hoist Operating on Jib Crane Used for Transferring Plates from Roller Skids to Plate Planer

Fig. 29.—One of the 40-Foot Hilles & Jones Plate Planers in Operation

Fig. 30.—37-Foot Hilles & Jones Bending Rolls. Served by Shepard Electric Hoist on Jib Crane

Fig. 31.—Oxy-Acetylene Cutting Apparatus Is Widely Used in the Assembling Shop

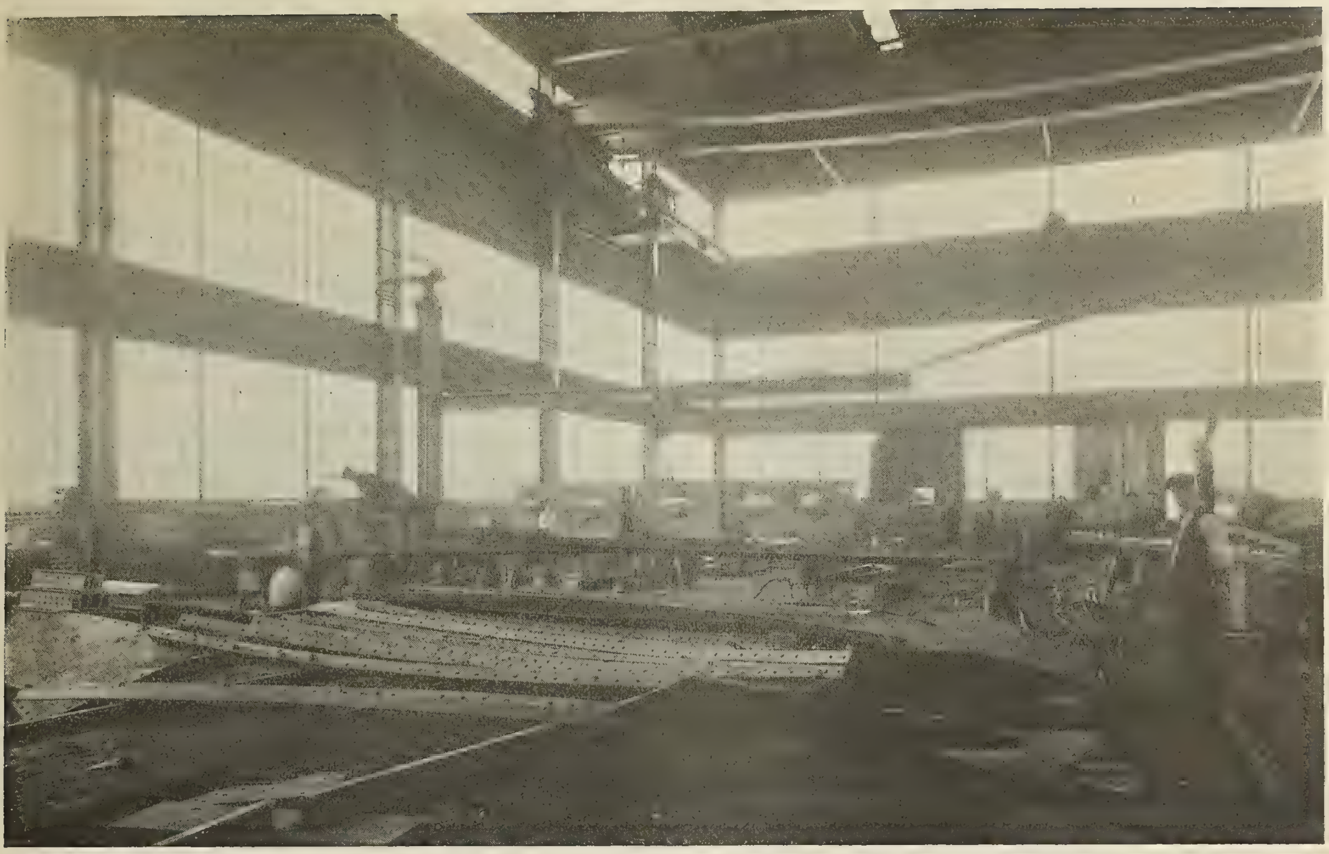


Fig. 32.—Corner of Assembling Shop. Large Sections Are Fitted Up and Riveted in the Shop Before Going to the Shipways

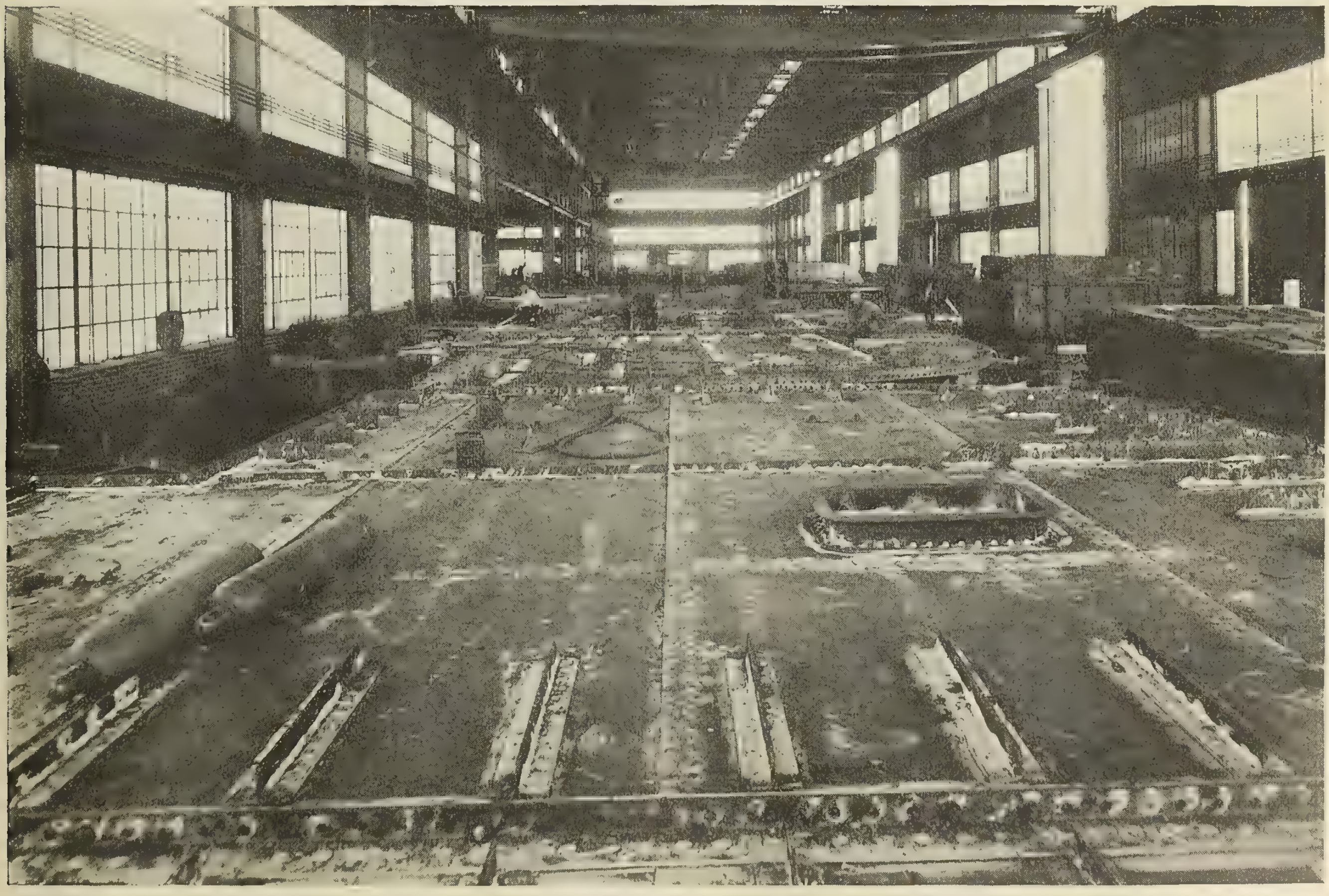


Fig. 33.—General View of Assembling Shop, Showing Bulkheads Riveted Up Ready for Installation on the Ships

Fig. 34.—Large Bay of Boiler Shop

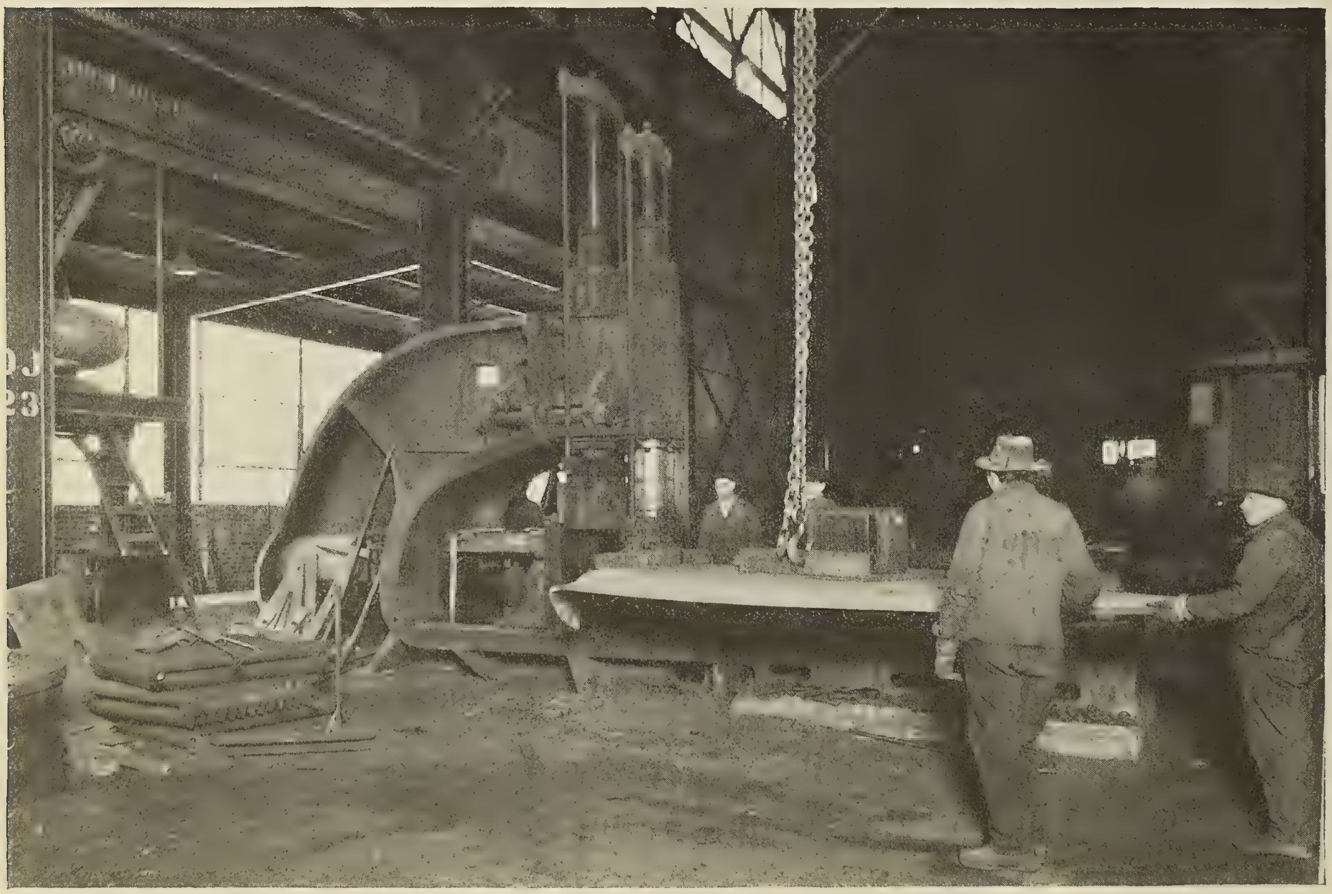


Fig. 35.—Flanging Boiler Head on Hydraulic Sectional Flanging Machine

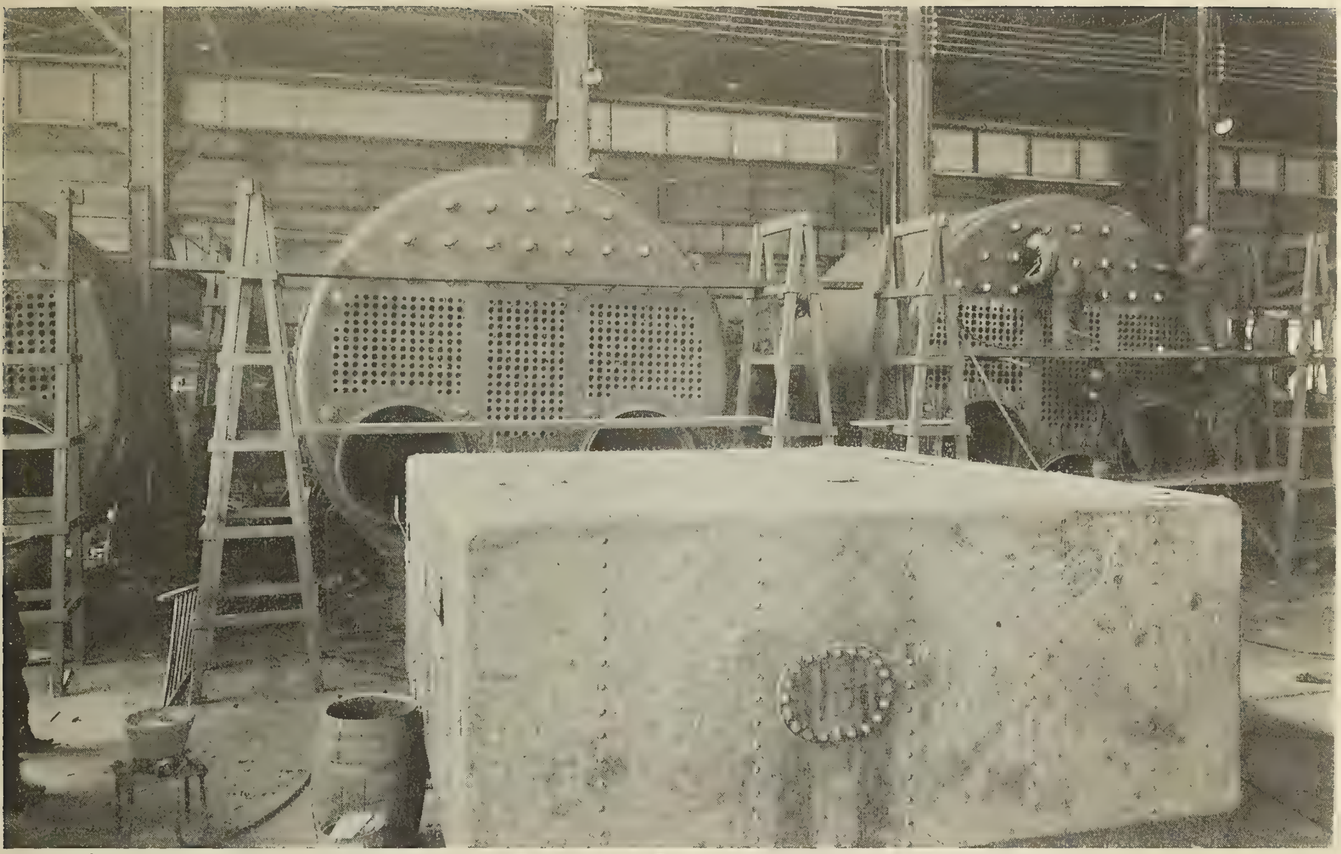


Fig. 36.—Assembling Floor of the Boiler Shop

Fig. 37.—General View of the Boiler Shop

Rand air compressors of 2,500 cubic feet capacity; two Laidlaw-Dunn-Gordon air compressors, of 2,800 cubic feet capacity, and one Bury air compressor of 5,000 cubic feet capacity. These machines are driven by Allis-Chalmers motors; there is also a hydraulic equipment consisting of twin 4½-inch by 12-inch pumps, supplied by the Oil City Pump & Machine Company, to furnish hydraulic pressure of 1,500 pounds per square inch. The buildings are heated by a hot water system, operated from a central heating plant in the yard.

The main shops in the yard are of steel frame construction with corrugated iron walls. At the entrance to the yard is a two-story brick office building, the main floor being occupied by the auditing department and lunch rooms and the second story by the executive offices and engine and hull drafting departments. Alongside the main office is the main entrance for the employees to the yard, with a time clock house and separate locker room equipped with individual lockers for each workman, as well as wash basins and shower baths.

Contractors and Officers of the Company

The buildings in the yard were put up by the Belmont Iron Works, Philadelphia, and Lewis F. Shoemaker & Company, Philadelphia. The concrete work on the shipways was carried out by the Raymond Concrete Pile Company, Philadelphia.

J. N. Pew, Jr., is president of the Sun Shipbuilding Company and J. Howard Pew, the vice-president. Robert Haig, formerly Lloyd's representative in Philadelphia, is general manager, Albert Ed. Saunders, naval architect, A. A. Howitz, chief engineer and J. K. Graham, manager of the hull department.

Morse School for Shipfitters

Elementary and Advanced Courses for Shipfitters Given at Morse Dry Dock and Repair Yard

SUPPLEMENTING the work which is being done by the New York State and city educational boards in establishing schools for shipworkers, the Morse Dry Dock and Repair Company, Brooklyn, N. Y., has opened a school for its own men. Two courses for shipfitters have been arranged—an elementary and an advance course.

Because of limited space and facilities, the classes have been restricted to a selected list of employees. About fifty men have been chosen, and only that number can be accommodated at the present time. As the courses are not long and are designed to cover but a short period of time, it is hoped that every man in the yard who desires to take advantage of them will, sooner or later, be afforded an opportunity to do so. When additional room and equipment are available the size of the classes will be gradually extended to meet the demands.

The elementary course consists of twelve lessons, and the classes meet every Monday and Thursday between 4 and 6 P. M., the hours being arranged to avoid interference with the work in the yard and also the supper time of the men attending. The advanced course consists of sixteen lessons, and the classes meet at the same hours on Tuesdays and Fridays. Walter Crawford, foreman of the hull department, is in charge of the classes.

The success which has attended the first school opened by the city and State authorities (the schools in Staten Island) and the overwhelming interest displayed by shipworkers has demonstrated the value of the project, and every effort is being made to hurry the establishment of other schools in Brooklyn and Manhattan.

The Morse school has been limited to the teaching of shipfitting to start with, but it is possible that, later on, courses in other branches of the trade will be given.

The elementary course in the Morse school is outlined as follows:

Lesson 1.—Method of making small paper templates for liners, particular attention being paid to lap, squareness and fit.

Lesson 2.—Study of uses and making of short angle clips and brackets. Study of squareness, fit and allowances.

Lesson 3.—Study of methods of fitting, marking and making of straight plates, deck, tank top plates. Study of correct application of templates, checking spaces in templates.

Lesson 4.—Study of laying out and making of auxiliary machinery foundations and general constructional work in angles, plates, channels. Study of angles and curves.

Lesson 5.—Methods of lining off and obtaining level lines, marking of positions of foundations.

Lesson 6.—Study of construction methods of laying out and making of main ship parts. Keels.

Lesson 7.—Frames, webs.

Lesson 8.—Shell plating.

Lesson 9.—Bulkheads.

Lesson 10.—Stem and stern.

Lesson 11.—Longitudinals.

Lesson 12.—Blueprint reading for shipfitters.

The advanced course is as follows:

Lesson 1.—Standard rivet sizes.

Lesson 2.—Spacing of rivets.

Lesson 3.—Study of suitable rivet spacing for odd parts, clips, brackets, etc.

Lesson 4.—Requirements for plain, watertight, oiltight work.

Lesson 5.—Study of parts to be planed for calking.

Lesson 6.—Laying out and study of level lines.

Lesson 7.—Study of shell plating. Method of laying out and repairing.

Lesson 8.—Study of parts to be furnaced and parts to be fitted and drilled in place.

Lesson 9.—Tank top and margin plates; study of development of plates. Repair of margin plates, the fitting of doubling plates.

Lesson 10.—Shaft tunnel and thrust recess trunk; study of development.

Lesson 11.—Mast and funnel making; method of laying out and building.

Lesson 12.—Bulkheads, method of laying out, molding and repairing.

Lesson 13.—Development of irregular shapes.

Lesson 14.—Watertight and non-watertight doors and manholes. Study of construction and fitting.

Lesson 15.—Deckhouses, casings, etc. Study of construction and building.

Lesson 16.—Marking of plates and conventions of markings.—*The Dry Dock Dial.*

Fig. 1.—S. S. *Jupiter*, First Vessel Built by Standard Shipbuilding Corporation for Emergency Fleet Corporation

The Shooters Island Shipyard

Reconstructed Plant of the Standard Shipbuilding Corporation — Its Standard Cargo Ships

AMONG the many shipyards which have grown up in the New York District during the past few years, the Standard Shipbuilding Corporation, at Shooters Island, is one of the most progressive, and bids fair to be a lasting asset to the port. The president of the company, José Marimon, has large interests in Cuba and the United States, and has a long list of successful enterprises to his credit.

Enlargement of the Plant

At the time when Mr. Marimon obtained control, in October, 1916, the capacity of the Shooters Island plant was very small, and he immediately took steps to make a real shipyard of it. Mr. E. S. Godoy, vice-president, was installed as general manager, and under his direction six building berths were put up, and the size of the island was increased about one-third by bulkheading and filling in shoal water on the north side. Extensions to the blacksmith shop and machine shop were put in hand, and a large quantity of new machinery ordered.

A serious blow was given to the production programme on December 28, a year ago, by a fire, which burned to the ground a frame building containing the mold loft and plate and boiler shop. All the molds already made for the ships which had been started were destroyed, as well as the machinery in the building, and a set of boilers under construction sustained some damage.

With characteristic energy, Mr. Godoy immediately set about repairing the damage. A new mold loft was started and on the fifteenth day it was finished and in use. A new steel building was ordered for the plate and boiler shops, and work started with a view of salving some of the machines.

The new building is 400 feet in length and 240 feet wide, divided into four 60-foot bays; three for the plate and angle shop, each with two 10-ton traveling cranes; and one for the boiler shop, served by two 50-ton cranes.

The machine shop, with the new extension, is 461 feet by 84 feet and is now one of the best equipped in the country.

Vessels Launched

The Standard Shipbuilding Corporation is now preparing to launch its fourth standard freighter for the U. S. Shipping Board Emergency Fleet Corporation. Two others, the *Muscatine* and the *Passaic*, are at present fitting out; and the first, the *Jupiter*, has already been delivered and has left an American port on her maiden voyage.

These ships are all similar. They are designed to carry 7,300 tons deadweight, and maintain a speed of 10½ knots.

The original designs of hull and engine were purchased, but they have been developed and all the necessary piping arrangements laid out under the direction of Mr. G. N.

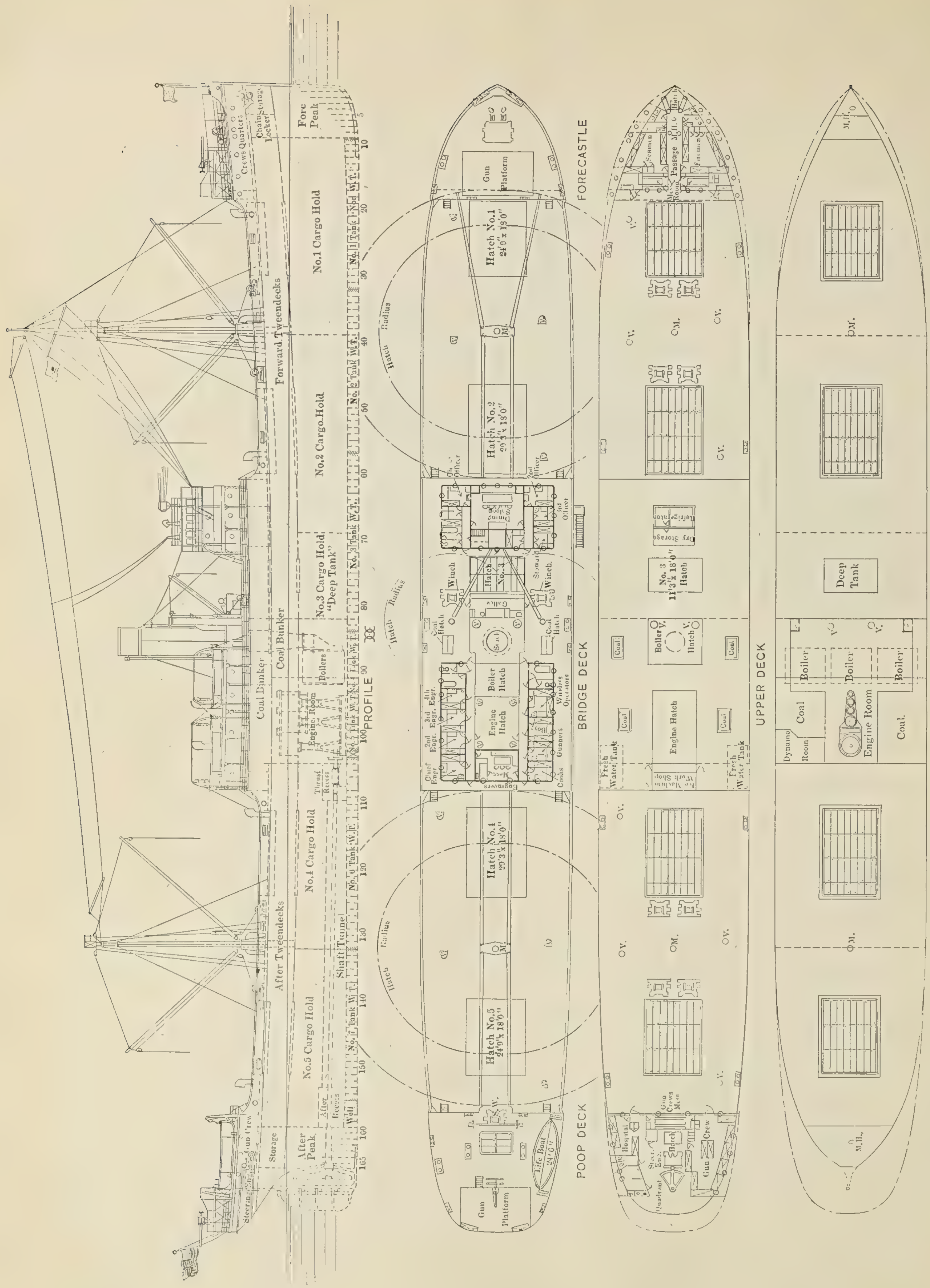


Fig. 2.—Capacity and Deck Plans of Standard Cargo Vessels Built by Standard Shipbuilding Corporation

Scott, the chief engineer of the Corporation, who also has had complete charge of the construction.

All the freighters at present being built at this plant were originally ordered by foreign interests, but on the outbreak of war between the United States and Germany they were requisitioned by the Emergency Fleet Corporation.

Description of the Standard Freighters

They are single screw steel ships, built and outfitted to Class 100-A1, under special survey of Lloyds Register of Shipping, and since they have been requisitioned by the Government they have been modified to comply with the requirements of the U. S. Steamboat Inspection.

They are of the two deck type with bridge, forecastle, and poop; two masts, one funnel, complete double bottom and seven watertight steel bulkheads extending to the upper deck, with a deep tank forward of the machinery space. The accommodation for the officers is amidships, for the crew in the forecastle, and for the armed guard in the poop.

The bridge, with pilot house, chart room, and wireless room, is arranged just forward of amidships, with the captain's quarters below and the main saloon with the officers' quarters on the deck below that.

The vessels have straight stem and semi-elliptical stern, with machinery amidships, and have been designed for the carriage and expeditious handling of bulk freight. For this purpose they are fitted with 11 winches and 10 derricks.

The principal dimensions are as follows:

Length over all	392 feet 6 inches
Length of Lloyd's measurements	377 feet 0 inches
Breadth molded	52 feet 0 inches
Depth at side to upper deck	29 feet 6 inches
Height between decks	10 feet 1 inch
Draft	23 feet 6 inches
Total deadweight on above draft	7,000 long tons
Indicated horsepower	2,500
Speed	10½ knots

The Hull

The keel is of the flat plate type in long lengths with butts connected by double butt straps. The center keelson, which is continuous, is fitted in conjunction with the flat plate keel and a double bottom; increased in the boiler space and reduced at the ends. Double angles, increased in the boiler space, are worked in at the keel and tank top.

In addition to the center keelson, there are two longitudinal side girders in the double bottom on either side of the center line. They are continuous between solid floors and are increased in the boiler space and reduced at the ends. Extra longitudinals are fitted under the main engine seating, and a half depth longitudinal in way of the double frames forward.

For three-fifths length forward and aft of the machinery space to the after peak bulkhead, solid floors are fitted from the center girder to the margin plate. Skeleton floors are fitted on the remaining frames. All solid floors with lightening holes are fitted in both peaks, and in the engine and boiler space. The double bottom runs throughout the length of the vessel, from the collision bulkhead to the after peak bulkhead, and is divided by watertight floors into seven fore-and-aft compartments. A deep ballast tank is fitted forward of the boiler room.

There are seven watertight bulkheads increased in thickness from the top to the bottom and stiffened with vertical channel stiffeners. The bulkheads are bracketed to the tank top and to decks.

From margin to upper deck the frames are 10-inch channels, spaced 27 inches from center to center amidships; each alternate main frame runs up to the bridge deck. The shell plating is arranged as "in" and "out" strakes, with full thickness liners, fitted at all outer strakes. Bilge keels constructed of bulb plates and angles are fitted for about 185 feet amidships.

Provision is made for the speedy handling of cargo by having five especially large hatches.

Propelling Machinery

The propelling machinery consists of a three-cylinder, triple expansion engine, having cylinders 24 inches, 40 inches and 70 inches in diameter by 48-inch stroke, supplied with steam by three single-ended Scotch boilers, designed for a working pressure of 190 pounds per square inch. The boilers are 14 feet in diameter by 12 feet long over all, each boiler having three corrugated furnaces 42 inches inside diameter, each leading to a separate combustion chamber. These boilers are designed for forced draft and fitted with an installation of the Howden type with Sturtevant blowers, the furnace fronts being designed by the builders.

The main condenser is of the Wheeler Admiralty type with 3,500 square feet of cooling surface, and is supported on a separate foundation behind the main engine. There is a direct connected air pump of the Edwards type with two bilge and two feed pumps, all driven off the pump levers on the low pressure engine. There is an independent centrifugal circulating pump with 14-inch suction and discharge connections which is driven by a 10-inch by 10-inch vertical engine.

The auxiliary outfit is very complete and includes one 500-square foot auxiliary condenser with combined air and circulating pump, one 12-inch by 8-inch by 24-inch vertical simplex feed pump, one Reilly multicoil feed water heater, one Reilly evaporator of 25 tons capacity, as well as an especially large ballast pump, fire pump, general service pumps and fresh water and sanitary pumps, all of which are of the horizontal duplex type.

The electrical equipment consists of two 15-kilowatt, direct-connected generator sets manufactured by the General Electric Company, which furnish power for the lighting, machine tools in the engine room, and wireless apparatus.

There is provision for carrying 83 tons of fresh water, and this, with a bunker capacity of 1,588 tons, gives the vessels a very large steaming radius.

Commodious Accommodations

In fitting up the crew's accommodation, especial attention has been paid to the comfort of the men who are necessarily cooped up for long periods. The officers' rooms are all of exceptional size, and are finished in white enamel and mahogany, with hair cushions on the seats.

The captain's accommodation and the main dining saloon are particularly noteworthy, all of them being paneled complete in mahogany with white ceilings.

The Standard Shipbuilding Corporation has had several difficult problems to meet in providing for the very large crew necessitated by the war conditions, the number of men being increased by 150 percent, but by taking advantage of the poop, a very neat arrangement has been worked out, which gives exceptional accommodations for all hands.

Chain falls should be looked over now and then. Worn sheeve blocks are dangerous, as are also worn pins.

Five Thousand-Ton Deadweight Fabricated Steel Cargo Steamer for Emergency Fleet

Standard Type of Vessel Being Built by Submarine Boat Corporation at Newark Bay Plant—Fabricating Principle Adopted

BECOMING thoroughly convinced by its success two years ago in building for the British Admiralty 550 submarine chasers, the parts of which were fabricated in one place and then put together in another location, that the same principles could be successfully applied to the building of large steel cargo vessels, the Submarine Boat Corporation of New York took up the design of such a vessel when the United States entered the war to meet the urgent demand for the rapid production of seagoing cargo tonnage on a large scale.

The basic principle of building fabricated ships is by no means new or untried. For years small vessels have been fabricated in English yards and shipped in knock-down form to the river Nile and other foreign waters, where they were assembled and placed in service. More recently the same principle has been utilized to a limited extent with marked success in both English and American shipyards on large steel vessels. The main drawback to increased production of steel merchant vessels when the United States entered the war was the fact that the steel mills for rolling ship plates and shapes were engaged to capacity to meet the enormous demands imposed by both naval and merchant ship construction. To overcome this difficulty, the Submarine Boat Corporation proposed the substitution of structural shapes and plates, which could be obtained from the steel mills in quantity, in place of the ordinary shipbuilding materials. This plan proved entirely feasible, and, as a result, the design for a 5,000-ton deadweight carrying capacity cargo vessel, described in the following pages, was worked out.

The design differs little from that of an ordinary cargo ship, except that it has been simplified by the greatest possible use of flat work and straight line sections which could be more easily and quickly fabricated by the structural steel and bridge building shops throughout the country. The tank top is carried out straight to the sides of the vessel, and in this respect follows the usual Lake practice. Where the ends fine in the usual form of margin plate is dispensed with, the sketch plates at the ends of the tank top strakes being increased in thickness to provide the necessary strength. The sides of the vessel are perfectly straight, except at the bow, where there is a slight flare. The decks are also perfectly flat, having neither crown nor sheer, except that from the forward end of the first hatch to the stem the deck has a straight sheer of 5 feet to give added buoyancy. The parallel middle body extends for 42.5 percent of the length of the vessel, the form of the hull having been determined from tests in the Washington towing tank.

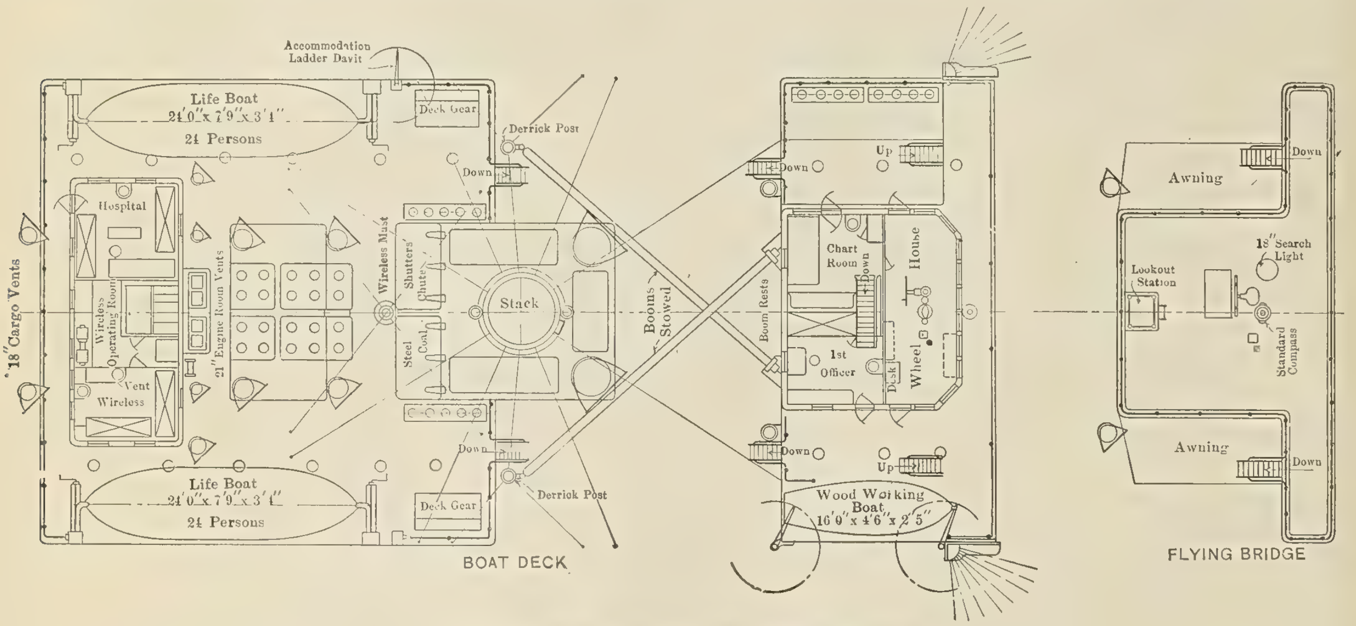


Fig. 1.—Plans of Boat Deck and Flying Bridge

Over 96 percent of the hull by weight is fabricated in outside shops. The shipyard, therefore, becomes simply an assembling department in the building of the ships. Plates which require rolling are laid out, sheared and punched in outside shops and shipped flat to the Newark yard, where they are rolled, as the large bending rolls required are not available in the bridge shops. Furnaced plates are pressed in hydraulic presses in the outside fabricating shops and shipped to the yard in blank form, repetition work making it possible for the outside shops to get out the dies required for this work and use them over and over again economically. Work on the shipways is reduced as far as possible by riveting together in the outside shops as large pieces as can be transported by rail to the yard. Detail drawings have been worked out for every piece of material going into the ship, 330 drawings having been made for the hull alone. In this way the plates are ordered to exact size, while the sketch plates at the ends of the vessel are designed with no re-entry cuts. The


Stores
Shelves

5,000-TON DEADWEIGHT FABRICATED STEEL CARGO STEAMER

Designed for U. S. Shipping Board Emergency Fleet Corporation and Built by Submarine Boat Corporation, New York

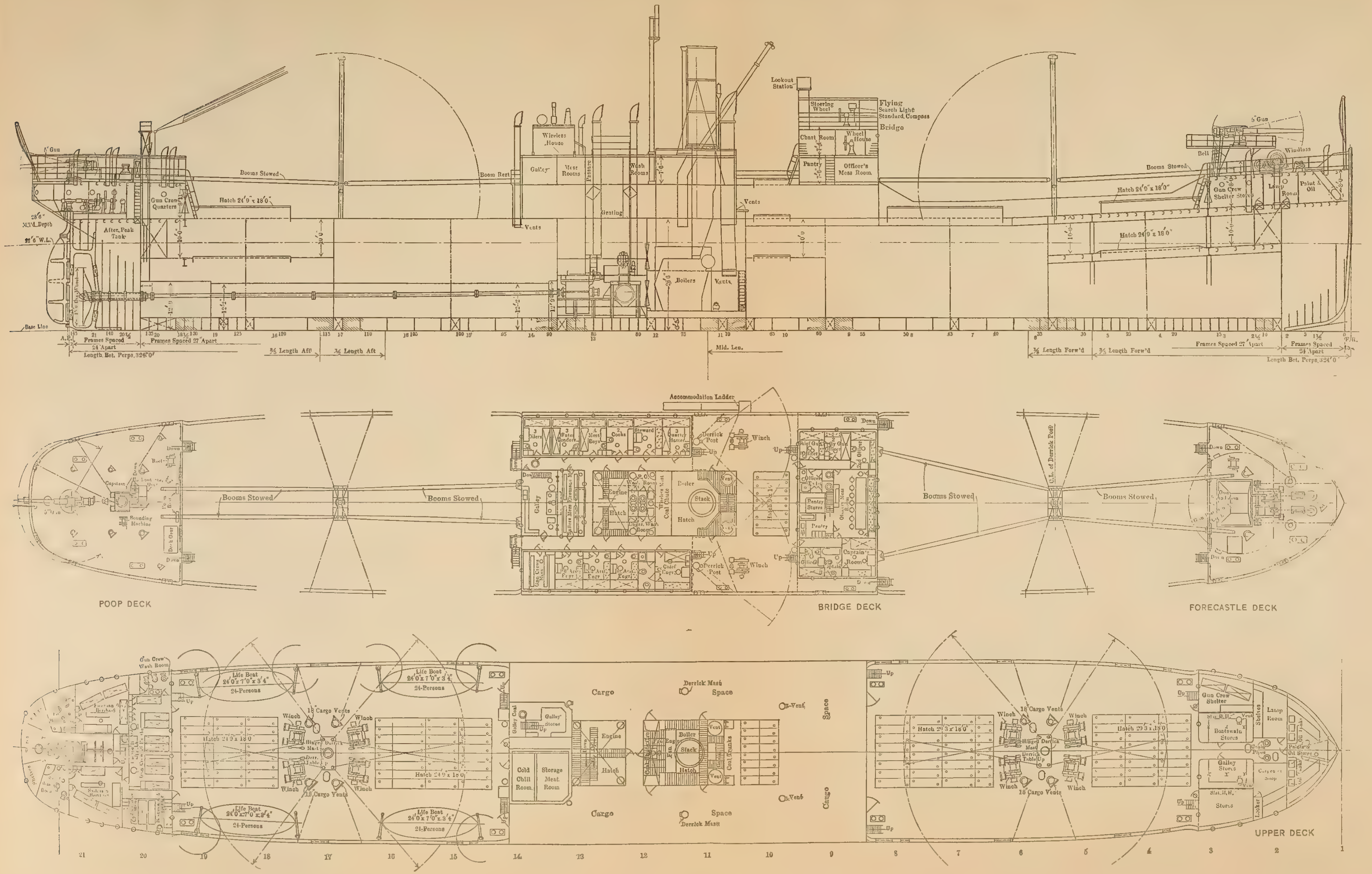


Fig. 2.—Profile and Deck Plans

5,000-TON DEADWEIGHT FABRICATED STEEL CARGO STEAMER

Designed for U. S. Shipping Board Emergency Fleet Corporation and Built by Submarine Boat Corporation, New York

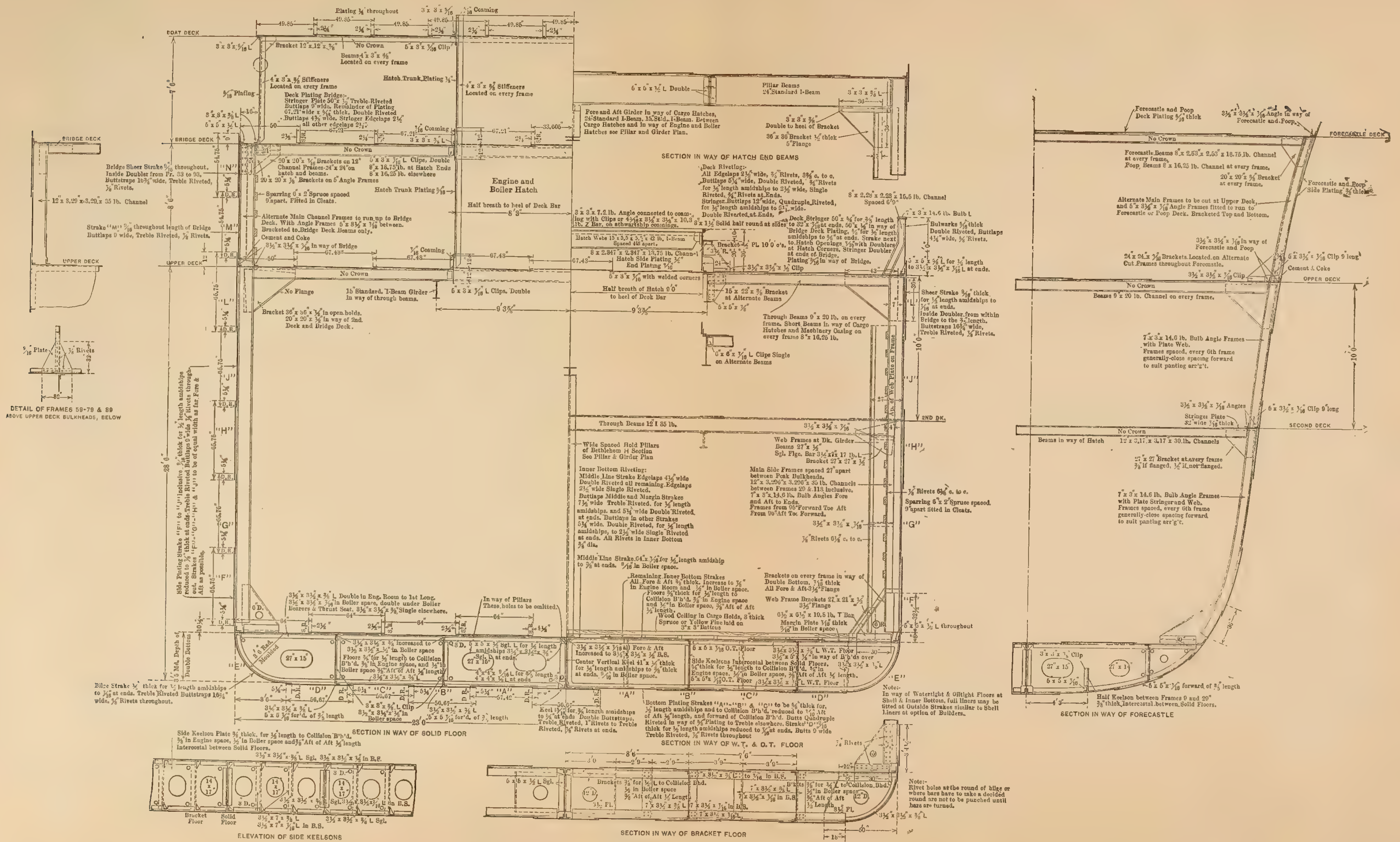


Fig. 3.—Transverse Sections, Showing Details of Hull Construction and Scantlings

frames at the ends of the vessel are bulb angles and are furnaced and bent in the yard. In the fabricated work all holes are punched and reamed out to neat size.

All of the material for the ships is ordered in accordance with instructions from the Washington office of the Emergency Fleet Corporation.

The principal dimensions of the vessel are as follows:

Length over all, about	335 feet 6 inches
Length betwen perpendiculars	324 feet
Beam, molded	46 feet
Depth at side to upper deck	28 feet 6 inches
Load draft, about	22 feet 6 inches

Built on the transverse system of framing, with a double bottom throughout, the vessel is of the single-deck type, with a partial second deck at the ends and also with bridge, forecastle and poop. All of the decks are worked level fore-and-aft, as well as transversely. In way of the wells, the bulwarks are of solid steel.

As shown by the drawings, the vessel has a straight stem with slight rake, a semi-elliptical stern and is rigged with one steel pole mast with a housing topmast located amidships and six derrick posts with cargo derricks and a single smokestack. In all, there are five cargo hatches at the upper deck, one hatch in the bridge deck and a small hatch in the poop deck.

Seven watertight steel bulkheads, six of which extend to the upper deck, divide the hull into four cargo holds, a deep tank and engine and boiler spaces.

The holds and 'tween decks will be used for cargo. The space in the forecastle will be used for crew's quarters, stores and a carpenter shop, and the space in the poop for the steering gear, gun crew and cargo or stores. In the bridge the space will be used for stores and cargo.

The forward and after peak tanks are arranged as salt water trimming tanks, and will be used for ballast. The after peak is also piped for carrying fresh water when needed. The entire double bottom, except compartment 4, will be used for oil fuel, the center keelson being made watertight throughout. Compartment 4, with the watertight center division, forms two tanks for boiler feed. A separate settling tank is also fitted in the boiler room, as shown on the plans. Double-bottom bilge wells are fitted all across and at the wings only for drainage of the deep tank bilges. While the double-bottom tanks are arranged primarily for carrying fuel oil, they will also be arranged for carrying water ballast.

As shown by the plans, the galley, officers' messroom, deck officers', stewards' and engineers' quarters, wash rooms, storerooms, cooks, etc., are located in the bridge deck houses.

Hull Construction

The stem is a rolled steel bar 9½ inches by 2½ inches, extending down below the turn of the forefoot and shaped to suit the keel at the lower end. It is designed in two lengths fitted with a scarf, although the stem may be in one piece if desired, of a uniform section throughout. If made in two lengths, the lower section adjoining the keel plate may be of cast steel instead of rolled steel.

The stern frame may be a forging or cast steel. The propeller post is 9½ inches by 6½ inches, and the rudder post 8½ inches by 6½ inches. The part of the frame between the propeller and rudder posts is flattened out at the heel. The scarfs are fitted above and below the shaft boss in the propeller post and in corresponding locations in the rudder post. The stern frame is provided with a boss for the stern tube, gudgeons for pintles and rudder stops. The rudder is of the single-plate type, with wrought or cast steel frame and arms.

The keel is of the flat-plate type 15/16-inch thick for three-fifths length amidships, reduced to ⅝ inch at the ends. It is worked in long plates joined with double butt straps, triple riveted with 1-inch rivets amidships and triple riveted with ⅞-inch rivets at the ends.

Double-Bottom Ballast and Fresh-Water Tanks

The double bottom, which extends throughout the length of the vessel from the collision bulkhead to well forward of the after-peak bulkhead, is constructed with open and solid floors, divided by watertight and oiltight floors, as shown on the plans, into six fore-and-aft compartments. The double-bottom tanks from forward to aft are as follows:

Tank No. 1, from collision bulkhead, fuel oil tank with watertight center division. Tanks Nos. 2 and 3, fuel oil tanks with watertight center division. Tank No. 4, boiler feed water, with watertight center division. Tanks Nos. 5 and 6, fuel oil tanks with watertight center division.

Access to No. 1 tank can be gained from No. 1 hold; to No. 2 tank, from No. 2 hold; to No. 3 tank, from the fireroom; to No. 4 tank, from the engine room; to Nos. 5 and 6 tanks, from the shaft tunnel and also from the holds.

At the after end of Nos. 1, 2, 3 and 4 holds, bilge suctions are provided at the wells formed in the double bottom. In the deep tank space forward of the boiler room side wells are fitted. A separate pump well runs clear across the tank at the after end of the engine room, and a similar pump well is provided at the after end of the shaft tunnel. Cofferdams separate the fuel oil and feed tanks in the fireroom and are provided with bilge suctions.

Framing

The main frames above the tank top are channels spaced 27 inches centers amidships, and bulb angles spaced 24 inches between centers at the ends. The side frames between the peak bulkheads are 17 inches by 3.29 inches by 3.29 inches by 34-pound channels between frames 29 and 113, inclusive. The frames fore and aft of the peak bulkheads are 7 inches by 3 inches by 14.6-pound bulb angles.

Alternate main channel frames within range of the bridge run up to the bridge deck with an alternate angle frame 5 inches by 3½ inches by 7/16 inch from the upper deck. Alternate main frames also run up to the poop and forecastle decks with an alternate angle frame from the upper deck. Frames in the holds in way of excessive bevel may be of angles or bulbs as approved.

The frames in the inner bottom on solid floors are 3½-inch by 3½-inch by ⅜-inch angles throughout, doubled from collision bulkhead to three-fifths of the length forward. The frames on the open floors in the inner bottom are also of angles, but they are 7 inches by 3½ inches by 7/16 inch to the lower turn of the bilge, 3½ inches by 3½ inches by ⅜ inch in way of the bilge. On the solid floors from frames 9 to 29, inclusive, the angles are 5 inches by 5 inches by 7/16 inch.

Reverse frames, consisting of angles 3½ inches by 3½ inches by ⅜ inch, are worked continuously on top of all solid floors in the double bottom. They are increased under the boilers and doubled throughout the engine space and under boiler bearers. The reverse frames in the peaks consist of angles 3½ inches by 3⅜ inches by ⅜ inch, fitted on every floor, while the reverse frames on the bracket floors are 7-inch by 3½-inch by ⅜-inch angles.

The center vertical keel is fitted continuous with the flat plate keel and is 41 inches by ½ inch for one-half the length of the hull amidships, increased to 9/16 inch in the boiler space and reduced to ⅜ inch at the ends. The center vertical keelson is continuous forward of frame 132 to

frame 9 and intercostal aft of frame 132 and forward of frame 9. The keelson is watertight between frames 9 to 34, 35 to 61, 62 to 70, 71 to 87, 88 to 113, and non-watertight from frames 114 to 132. Double angles, 3½ inches by 3½ inches by 7/16 inch, connect the center keelson to the tank top, increased to 3½ inches by 3½ inches by ½ inch in the boiler space. Double angles, 4 inches by 4 inches by 9/16 inch, are worked at the keel for three-fifths the length and reduced to 4 inches by 4 inches by ½ inch at the ends.

Two longitudinal side keelsons are fitted in the double bottom on each side of the center line. They are continuous between solid floors and are increased in the boiler space. The longitudinal plates are connected to the shell plating by angles and also to the tank top plating by angles which are increased in the boiler space. They are connected to the solid floors by angles and to the frames and reverse frames at open floors by angles.

Throughout the length of the ship the margin plate of the tank top is fitted level to the bilges and is continuous, being increased in thickness in the boiler space. The margin plate is connected to the shell by an angle bar.

Web frames are fitted in the engine space and in the 'tween decks over the watertight bulkheads. Side stringers are fitted forward in the hold and in the 'tween decks only as required for panting strength at the ends. Portable strong beams are fitted in the engine and boiler space.

Deck Beams

None of the deck beams has either camber or pitch. At the upper deck through-beams, consisting of 9-inch by 20-pound channels, are fitted to every frame. Short beams, consisting of 8-inch by 16.25-pound channels, are fitted in way of the cargo hatches and machinery casings. Strong beams, consisting of 24-inch standard I-beams, are fitted in way of the hatch end web frames.

In the 'tween decks space in holds Nos. 1 and 4 only deck beams consisting of 12-inch by 3.29-inch by 3.29-inch by 35-pound channels are fitted on alternate frames. The through beams at the bridge deck, which are fitted to every frame, are 8-inch by 16.25-pound channels. At the poop and forecastle deck beams consisting of 8-inch by 2.53-inch by 2.53-inch by 18.75-pound channels are fitted on every frame. At the boat deck the beams consist of 4-inch by 3-inch by ⅜-inch angles fitted to every frame.

Deck and Shell Plating

The upper forecastle, poop and bridge decks are complete steel decks with the plating fitted in in-and-out strakes with parallel liners. The boat deck is also plated throughout.

The shell plating is arranged in in-and-out strakes with full thickness liners fitted at all out strakes. At the stern frame the plating is of midship thickness. Three strakes next to the keel are maintained at midship thickness to the collision bulkhead. The boss plating is 11/16 inch thick. Details of the shell and deck plating, as well as of the riveting, will be found on the midship section.

Bulkheads

As shown on the general plans, there are in all seven watertight bulkheads, six of which extend to the upper deck and one to the 'tween deck level. The collision bulkhead is extended watertight to the forecastle deck. The forward bulkhead of the deep tank extends only to the 'tween deck level. Vertical stiffeners only, spaced 30 inches apart, are fitted to the bulkheads.

Fresh water for culinary use is carried in two fresh-water tanks placed in the engine room, having a total capacity of about 7,000 gallons. A gravity tank of about 400 gallons capacity is placed on the boat deck.

In the holds, one row of wide-spaced pillars of H-section, filled with wood to prevent chafing, is fitted; the pillars fitted at the hatch ends are set back one beam space. Deck girders worked in way of the hatch coamings, as shown on the plans, are carried with girder beams, which in turn are supported with a center pillar, all designed to carry the loads in accordance with best practice.

Cargo-Handling Equipment

Cargo is handled through five main cargo hatches through the upper deck and two hatches through the second deck beams, one hatch through the bridge deck, one hatch through the poop deck and a watertight hatch over the peak tank.

Six steel derrick posts are fitted at the hatches, as shown in the general plans. Holes are cut in the posts under the decks for ventilation and fitted with a sliding plate cover. The derrick posts in the wells are of the hinged-down type. The tops of the derrick posts at No. 3 hatch are fitted with a mushroom top vent.

At hatches Nos. 1, 2, 4 and 5 eight cargo booms are fitted, designed for handling 5-ton loads.

The hatch covers are fitted in built-up sections made of 3-inch spruce fitted with lifting bolts of half-round bar through-bolted. The covers are arranged to lie fore-and-aft on the hatch webs. The deep tank hatches are covered with steel covers.

The cargo will be handled by eight double-cylinder, single-drum, single-geared reversible winches, 8¼ inches by 8 inches, located at the hatches on the upper deck, and two 6¼-inch by 8-inch, double-cylinder, single-drum geared reversible winches, with two winch heads on the bridge deck at hatch No. 3.

The steam winches are connected with galvanized iron steam and exhaust pipes with copper branches from the main line to the winches in such a way that the winches may be driven from either of the main boilers independently of the other. The steam and exhaust pipes to the winches are run on the upper deck, and the deck machinery steam and exhaust is controlled from the engine room.

Watertight Doors

A sliding, watertight door is fitted in the after engine room bulkhead operated by a screw arrangement from the deck. One hinged watertight cargo door is also fitted on each side in the bulkhead forward and weather-tight doors at the after end of the bridge.

Hull Cementing

Reverse feed tanks, fore and after peak tanks, at the lower and upper deck stringers in bridge, poop and forecastle head and all pockets and spaces where found necessary will be cemented with Portland cement and sharp sand. In the reserve feed tank the cement will be about 1½ inches thick. The remaining surface of the reserve feed tank and peak tanks will be thoroughly coated with cement wash.

Inside the chain lockers one coat of bitumastic enamel will be applied. The tank top in the engine room, the engine foundations, tank top in the boiler space, including boiler saddles and bulkheads for 18 inches above the fire-room floor, the bulkheads in the cargo spaces in the bottom for 18 inches above the tank top, including also the shell and frame brackets up to the top of the brackets, and all drain wells will receive one coat of bitumen solution and one coat of bitumen covering. The tank top in the cargo spaces will also be coated with native tar and cement before the ceiling is laid.

The oil fuel settling tank and the double-bottom tanks for fuel oil are left bare inside.

Ventilation

The living quarters, holds and working spaces are ventilated by natural ventilation by means of metal ventilators and cowls.

General Arrangement

The wheel and chart house are on the boat deck, above which is the flying bridge. Aft on the boat deck is the hospital and wireless cabin.

In the forward deck house on the bridge deck are the officers' messroom connected with the pantry and the captain's room and quarters for other officers. Alongside the engine and boiler casing, on the bridge deck, are quarters for the engineers, quartermasters and stewards, while at the after end of the deck house on the centerline is the galley.

The gun and ship's crews are berthed in the poop and forecastle on the upper deck, the space amidships around the engine and boiler casing being given over to cargo space.

Deck Machinery

The deck machinery includes a spur-geared windlass with engine cylinder, 8 inches by 10 inches, located on the forecastle head with the engine on the same bedplate. The windlass is fitted with two wildcats and two winch heads for warping the ship. Both hand and steam steering gear are provided, the steam steering gear being of the right- and left-hand screw type located aft in the poop and direct connected to the rudder head.

Located on the poop is the steam capstan with double 6-inch by 6-inch cylinders. The vessel is lighted with electricity supplied by one 10-kilowatt marine type generating set direct connected and driven by a turbine. For cold storage and refrigeration an ice machine of 1-ton capacity for a direct expansion ammonia system is provided. The living quarters are heated by steam, and a complete set of instruments and appliances for navigating and handling the ship are provided.

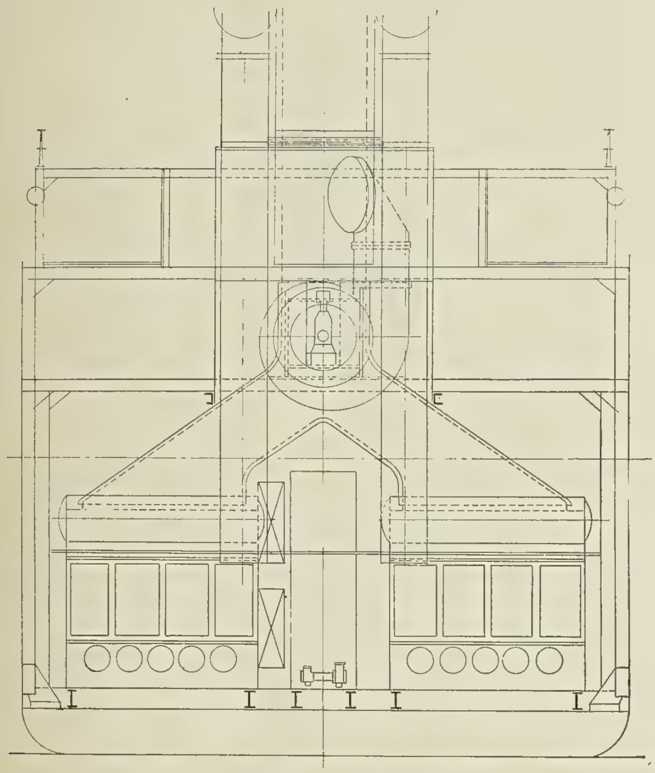


Fig. 4.—Section Through Fireroom

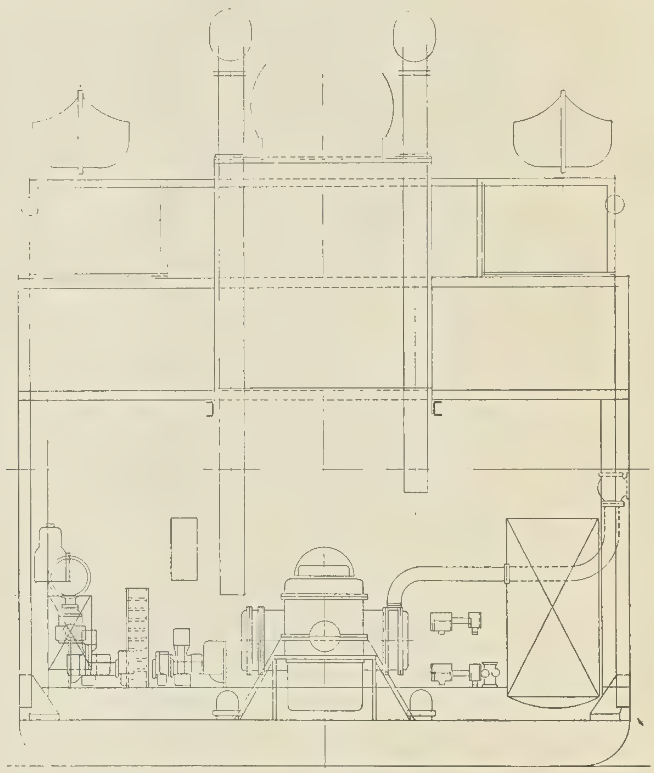


Fig. 5.—Section Through Engine Room

Boilers

Steam is supplied at a working pressure of 200 pounds per square inch by two Babcock & Wilcox watertube boilers, having a total heating surface of 5,800 square feet, fired by oil fuel under natural draft by means of Peabody mechanical oil-burning apparatus.

The boilers are arranged athwartships with one common fireroom on the forward side. They are connected by uptakes to a single smokestack extending 76 feet above the base line.

For the oil-burning system there is installed in the fireroom for pumping oil from the inner bottom tanks and discharging to settling tanks, a horizontal duplex pump 7½ inches by 6 inches by 10 inches. The inner bottom and settling tanks are provided with heating coils. The filling line from the deck to the oil tanks is so arranged that the oil transfer pump can discharge overboard through it on both sides of the ship.

To draw the oil from the settling tanks and inner bottom tanks and discharge through strainers and oil heaters to the burners there are two horizontal simplex pumps 4½ inches by 2¾ inches by 6 inches; two fuel oil heaters and duplex suction and discharge strainers are installed in the oil lines so arranged that either strainer can be cleaned without shutting down the pumps. The heaters are supplied with live steam and drain through a trap to the inspection tank. The piping is so arranged that either pump can pump through or around either heater.

Propelling Machinery

Propulsion is by a single, four-bladed screw of about 15 feet 6 inches diameter, driven by a geared Westinghouse turbine designed to develop 1,500 shaft horsepower

with the propeller shaft turning at 90 revolutions per minute. The turbine is connected to the propeller shaft by a helical, double-reduction gear with a ratio of speed reduction of 40 to 1.

The backing turbine is incorporated in the same casing as the ahead turbine, and when supplied with the same amount of steam as used for full-load conditions will develop not less than one-third of the full speed of the ahead torque on not more than one-third of the full speed revolutions per minute.

With dry, saturated steam at 185 pounds gage pressure at the throttle and 28 inches vacuum referred to a 30-inch barometer in the condenser, the steam consumption of the turbine when going ahead at 90 revolutions per minute of the main shaft and developing 1,500 shaft horsepower is not to exceed 12.5 pounds per shaft horsepower hour.

The thrust bearing of the Kingsbury type is incorporated with the low-speed gear and casing. The line shafting of forged steel is 10⅝ inches in way of the bearings and 10½ inches diameter elsewhere. The propeller shaft, also of forged steel, is 11½ inches diameter.

Each length of line shaft will have one or two spring bearings, depending upon the length of the shaft sections, with the bearings 15 inches long. The bearings will be of cast iron with a bottom section lined with white metal. Cast iron caps which will not bear on the shaft and which will be arranged for supporting the oil boxes will be fitted. A water service pipe will be fitted along the shaft tunnel with a spray pipe at each bearing.

The stern tube of cast iron has at each end composition bushings fitted with sections of lignum vitæ.

The lubrication of the turbine bearings and gears is by oil supplied by a gravity tank located in the engine hatch. This oil is supplied from the lubricating oil pumps, which draw from the drain tank underneath the gears and discharge through coolers to the gravity tank. Two oil coolers of ample capacity for cooling the lubricating oil are fitted. Water for the coolers is supplied by the main circulating pump and sanitary pump.

Engine-Room Auxiliaries

The condenser apparatus consists of a main cylindrical surface condenser having about 2,400 square feet of condensing surface, for which water will be supplied by a centrifugal pump with 12-inch suction and discharge, and having a capacity of 2,400 gallons per minute against a head of 15 feet. The circulating pump will be driven through gearing by a steam turbine.

The main air pumping equipment includes two turbo-driven, hot-well pumps and two Westinghouse Le Blanc air ejectors. The condensate pumps and piping are in duplicate, and each hot-well pump and air ejector is of ample capacity to maintain a vacuum under full power conditions. They are so piped up that any unit can be overhauled without interfering with the operation of the others.

Independent Pumps

The independent pumps comprise the following:

Two main and auxiliary feed pumps, vertical simplex, Westinghouse type, 9½ inches by 6 inches by 10 inches.

One ballast pump, horizontal duplex type, 10 inches by 10 inches by 12 inches.

One fire bilge and general service pump, horizontal duplex type, 10 inches by 6 inches by 10 inches.

One sanitary pump, horizontal duplex type, 6 inches by 5¾ inches by 6 inches.

One fresh-water pump, horizontal duplex type, 4½ inches by 3¾ inches by 4 inches.

One evaporator feed and ice machine condenser pump, horizontal duplex type, 4½ inches by 3¾ inches by 4 inches.

One auxiliary air and circulating pump, horizontal simplex type, 10 inches by 12 inches by 12 inches.

One oil transfer pump, horizontal duplex type, 7½ inches by 6 inches by 10 inches.

Two oil service pumps, horizontal simplex type, 4½ inches by 2¾ inches by 6 inches.

One auxiliary lubricating oil pump, horizontal duplex type, 6 inches by 5¾ inches by 6 inches.

Duty and Connections for Pumps

The duty and connections for the pumps are in general as follows:

The main air ejectors and condensate pumps draw from the main condenser and discharge to the feed and filter tank.

The main circulating pump draws from the sea and bilge and discharges overboard through the main condenser.

The main feed pump draws from the feed and filter tank and reserve feed tanks and discharges to the boilers either through the feed water heater or direct.

The auxiliary feed pump draws from the feed and filter tank, reserve feed tanks, and sea and bottom blows and discharges to the main feed line, auxiliary feed line, fire service and overboard.

The fire and bilge pump draws from the bilge main, engine room bilge, ballast main and sea, and discharges to the fire main, overboard.

The ballast pump draws from the sea, ballast main and bilge main and discharges to the main condenser circulating water, auxiliary condenser circulating water and overboard.

The sanitary pump draws from the sea and discharges to the sanitary system, water service and oil cooler.

The fresh-water pump draws from the engine room fresh-water tanks and reserve feed tanks and discharges to the fresh-water system.

The injector draws from the sea and reserve tanks and discharges to the auxiliary feed line. The evaporator feed pump draws from the condenser to discharge overboard and sea and discharges to the evaporator and ice machine condenser.

The auxiliary air and circulator pump draws from the sea and auxiliary condenser and discharges to the feed tank and overboard.

Auxiliaries

In addition to the pumps, the engine-room auxiliaries include a feed water heater of sufficient capacity to heat 25,000 pounds of feed water per hour from 90 to 212 degrees when using exhaust steam at 5 pounds per square inch gage pressure. It is specified that the drop in pressure of the feed water passing through the tubes shall not exceed 12 pounds per square inch.

A feed and filter tank of 800 gallons capacity is installed in the engine room. The feed tank is fitted with a float and a chronometer valve gear for automatically regulating the main auxiliary feed pump. A 2½-inch pipe is led from the feed tank to carry off vapor.

One injector of the double-tube type with 2-inch suction and discharge is installed with connections to draw from the sea and reserve feed tanks and discharge to the boilers.

An evaporator with a capacity of 15 tons in twelve hours is also installed.

The exhaust from all auxiliary machinery is condensed in an auxiliary condenser located in the engine room and having 800 square feet cooling surface. It is mounted on a combined air and circulating pump.

Development of the Diesel Type Marine Heavy Oil Engine in the United States

American Diesel Engine Builders—West Coast Activities—Economy and Reliability—Steam and Electrical Auxiliaries—Operation of the Engines

BY GEORGE A. COLLEY*

IN dealing with the development of the Diesel type of heavy oil motor for marine use in this country, a resumé of what has already been accomplished is necessary, followed by what is now being done to advance the industry and what will have to be done if it is to successfully compete with steam.

The west coast builders have undoubtedly done more for the rapid progress of the heavy oil engine in general than any other part of the country, by first installing auxiliary power in their large lumber carriers and then gradually overcoming the prejudice which they met everywhere and making them full motor powered ships.

Foreign Designs Adopted

Spurred on by the sight of foreign-owned and built ocean-going motorships in our ports, a few of our large eastern yards have made arrangements for building Diesel engines from foreign designs, while several other foreign-designed engines are now being built in various parts of the country.

The Navy Department has also gone into the field extensively, although to a much smaller extent than the foreign navies. At the same time, the installation in the fuel ship *Maumee* was one of the most radical steps ever taken to advance the Diesel engine in this country.

Navy Department's Investigations

At this writing it is, of course, impossible to give detailed results of the performance of this ship, but there can be no doubt but that our Navy Department will have at the end of the war an enormous fund of invaluable information on the Diesel engine of both high- and low-speed types.

There is also no doubt but that the close of hostilities will see the yachting interests of the country in the Diesel game to an increasing extent. The writer also believes they will lean to the full Diesel type of motor of fairly large power, as previous to the commencement of hostilities James Craig had powered several small yachts with an out-and-out American-built Diesel engine, while Alexander Winton has had a pair of V-type Winton Diesel motors in his own yacht *La Belle* for over two years.

Reduction Gears Introduced

Both of the above firms are in the commercial motor game to stay, and the Winton people have tripled their shop capacity within the past twelve months and have contracts ahead for over two years' work. The horsepower called for in these contracts ranges from generating sets of 60-kilowatt capacity to main engine units of 1,000 shaft horsepower. They have also introduced the reduction gear into their work, saving a tremendous amount of weight in the main engines by so doing for a given power and propeller speed.

In the large commercial sizes the prospective customer will find that the west coast engine builders are alive to the situation, as the Atlas-Imperial Company are building units up to 1,200 horsepower, and the surface ignition engine builders are pushing their product also. In the East, McIntosh & Seymour are prepared to build engines up to 1,350 horsepower, while both the Werkspoor and Burmeister & Wain motors can be contracted for from American builders.

Pacific Coast Motorships

The writer has recently inspected several motorships built at Portland, Oregon, by the Supple & Ballin Corporation, the Peninsula Shipbuilding Company and the G. M. Standifer Company. The first and last companies have turned out a strictly full-powered motorship, the Ballin ship being a 4,500-ton deadweight ship with two eight-cylinder, 500-horsepower Winton's direct connected, while the Standifer ship is a vessel of about 3,500 tons deadweight capacity, powered with two six-cylinder, 350-horsepower Winton motors geared three to one to the propeller shaft. Both of these vessels have steam-driven auxiliaries, except that the Ballin ship has an electric steering engine.

The Peninsula ships are of 2,300 tons deadweight, and are to be powered with two 350-horsepower Wintons, direct connected. They also are to have steam auxiliaries.

These vessels are representative types of what is being built throughout the Douglas fir district, and the workmanship throughout is of the best.

The various oil companies can be counted on to help things along, as they all have tried out various types of motor-driven ships with sufficiently satisfactory results to warrant further operations along the same lines.

Initial Errors Must Be Corrected

Mistakes have been made in the past which have retarded progress and created a distrust of the oil engine generally which will be hard to overcome, but a frank admission of errors and a willingness to correct them by builders both of hull and machinery will do much to help matters.

These mistakes and their remedies, also the various other points bearing on the building of a substantial foundation under the American motorship trade, the writer proposes to discuss in their relation to the various interested parties, namely, the owner or operating company, the operating engineer, the engine builder, the installing yard and the naval architect.

The owner, or operating company, has certain conditions which must be fulfilled. His requirements are that his installation shall be reliable, economical, both as regards running expense and upkeep, easy of repair and of reasonable first cost. He also must be assured that his auxiliaries will be taken care of properly.

Reliability the First Consideration

Regarding reliability, the average owner does not care to experiment at his own expense, and the engine builder should be prepared to meet him more than half way in regard to terms, guarantees, etc., and once having done so, to follow them up with the same amount of zeal that was used in obtaining the order.

* Tams, Lemoine and Crane, naval architects, New York.

The owner will also want to know if the particular size of machine he intends using has ever been built before. At present the average answer will be negative, as the average builder in this country has not had time to experiment on a machine of each of the various sizes he intends building. One builder has adopted a practice of building a single-cylinder machine of each size and obtaining data therefrom. This is a move in the right direction, as there has been too great a tendency toward selling machines regardless of their suitability for the work.

Fuel Economy

As regards fuel economy, the Diesel type has a tremendous margin over the best steam practice, but in many installations the lubricating oil cost reduces this margin to a very large extent. A carefully worked out system of filtration and cooling for re-use of the lubricating oil will help materially.

Upkeep and ease of repair are vital. The repair bills and layoffs due to engine trouble must be reduced by careful attention to detail. Ease of repair can be furthered to a great extent by careful attention to the location of accessories and auxiliaries, as half of the repair expenses in many cases are due to the time taken to remove and replace piping and other gear in no way connected with the trouble, but so in the way that nothing can be done with them in place.

Regarding reasonable first cost based on power delivered, fair competition will probably take care of this question automatically.

Auxiliaries—Electric Installation Ideal

The question of auxiliaries is one which many of the engine builders have overlooked to a large extent. Two general schemes present themselves for consideration, and the Diesel engine salesman should be well posted on both before attempting to talk business. They are, first, the straight steam-driven auxiliary installation supplied with steam from a donkey boiler, which should be a real oil-burner, not a makeshift, and, second, the electric-driven installation with oil engine-driven generating sets. Probably the electric installation properly worked up with breakdown sets for emergency use and a small watertube, oil-fired boiler for heating, hot water service, etc., would be the ideal installation.

Above all things in the auxiliary proposition, give the owner enough power. Many of the smaller motorships at present are using the old-fashioned inefficient firetube donkey boilers of just capacity enough for the winches when the latter are new. After they have been in commission a short time there is a continual loss of time when loading and unloading, which, under present conditions, is nothing short of criminal.

Steam Auxiliaries

A ship equipped with steam auxiliaries should be fitted with condensing and evaporating apparatus for make up. The writer also believes that a carefully worked out system of fresh-water cooling for the main engine would be well worth a trial.

Proper attention should also be paid to adequate bilge and fire service, electric lighting, etc. Possibly the engine builder will think these matters out of his province; but they are the questions which the owner will ask, and if he is met by answers that indicate the engineer's knowledge of his subject much will be gained.

The operating engineer is more properly interested in the improvement of fuel handling devices, attention to lubrication problems, and the like. The writer believes that most of the builders will do well to bring into use many of the standard strainers, filters, coolers, and the like, now on the market for fuel and lubricating oils, rather than to attempt to go all over the work of the very competent engineers who designed them. The writer has seen filters and strainers for use with Diesel motors which are crudities compared with the accessories used in steam practice.

Trained Operating Engineers Badly Needed

Efficient operating engineers are at a premium and oil engine manufacturers generally would do well to take a leaf from the books of some of the largest and most successful machinery manufacturers. These latter have schools for their embryo salesmen where they learn every detail of the machinery right in the shops, so that when sent on the road they are capable of selling, erecting and making the initial run of the machine. Some such scheme used with regard to engine crews would soon give us a set of men who would be boosting the game and not knocking it.

The engine builder has some very strong opinions with regard to owners and operating engineers generally, not without a good deal of cause. Many owners seem to think that because their machinery is oil-driven almost any sort of an engineer can run it, when, as a matter of fact, at this stage of the business it will take the closest kind of co-operation between builder and engineer to make things run smoothly.

Builders Should Do More Than Supply the Engines

The builders will also do well to follow the methods of the large marine turbine manufacturers, who are always at the disposal of their customers for information of all kinds having a bearing on their installations. They are never content merely to sell their main units, but always make it a point to know whether the rest of the equipment, and even the ship itself, will co-ordinate with what they are furnishing to make a perfect whole.

The installing engineer, or shipyard, also has an extremely important part in the success of the outfit, more particularly so with regard to a full Diesel installation than with the surface ignition type. The high pressure air lines must be installed with the greatest care, which means constant watchfulness in these days of green workmen and rush jobs. These lines should be as short as possible and the whole layout should be as simple as conditions will allow. This same thing applies to the entire main engine and auxiliary installation.

What the Naval Architect Can Do

The naval architect's connection with the advancement of the Diesel engine should be along the lines of the careful and accurate co-ordination of all the before-mentioned points. It should be his duty to impress on engine builders the necessity of obtaining proper engine speed for any particular type of ship. Underpowering and lack of attention to auxiliaries or other details will do much to slow up progress.

In conclusion, no time was ever riper for the advancement of any industry than is the present time for the advancement of the motorship. With the New York State barge canal about to open for traffic, and, in fact, all the inland waterways and coastwise trade of the country in need of motor-driven craft of all kinds, experience along these smaller lines can be gathered to such an extent that when hostilities cease the motorship should have no difficulty in giving the steamship the race of its life.

In some ships the bilge gets more oil than the engine.

Fig. 1.—185-Foot Schooner *Dornfontein*, in Frame on January 29, 1918, Will Be Fitted with a 250-Horsepower Kahlenberg Oil Engine

Motorships and Their Propelling Machinery

Six Classes of Vessels Being Equipped with Internal Combustion Engines—Typical Designs—Rapid Development of Motorship Inevitable

BY J. MURRAY WATTS*

THE use of the internal combustion engine using oil fuel has lately increased to a very considerable extent, and has become a formidable rival to the steam engine in practically all vessels where powers of under 10,000 horsepower can be employed. The liner, the battleship and the destroyer are about the only three types of ships in which the oil engine has not been applied. The high-speed turbines and watertube boilers of the destroyer are far less in weight per horsepower than Diesel engines, and in the case of larger ships even where the item of keeping down the weight is not the greatest essential, oil engines have not been built in sufficiently large units to give satisfactory service.

This narrows the field of the oil-engine-propelled vessel down to six classes of vessels, i. e., the submarine, the bulk freighter, the small passenger boat, the shoal-draft river boat, the motor tug and the yacht. In this article we will not discuss the submarine at length, as a technical description of our new boats is not advisable in time of war, and the main details of the latest type of Austro-German submarines are pretty generally known; the class *U*-21 to *U*-32 having a surface displacement of 650 tons, displacement submerged 800 tons, length 213 feet 3 inches, brake horsepower, Diesel engines, 1,800; brake horsepower, electric motors, 800; maximum speed, surface, 16 knots; submerged, 10 knots; radius, surface, 1,500 miles; torpedo tubes, four, with 18-inch Schwatz Kopf torpedoes; guns, two of 2.46-inch caliber. The latest types, from *U*-33 on, have Diesel engines, 2,500 brake horsepower, and 5.9-inch guns.

Fig. 2 shows the plan of a 213-foot submarine with a special life-saving device developed by the author, according to the "Pointiere" patents.

Fig. 4 shows an up-to-date type of steel motor vessel now being designed by this firm, 424 feet long over all, 406 feet between perpendiculars, 54 feet beam, 37 feet depth and 25 feet 6 inches normal draft, corresponding to 12,000 tons displacement. The power is furnished by two Diesel engines of 1,600 horsepower apiece, with the normal revolutions of 128 per minute, which gives 11¾ knots under full load conditions. A steam freighter of this class would be propelled by a single screw, and would have somewhat greater efficiency owing to a larger propeller and slower speed of revolutions, say 80 revolutions per minute. In practice, the Diesel engine installation has several advantages, in spite of the extra weight and resistance of the spectacle framing and smaller screws. The fact that smaller propellers are used means that, whether the vessel is in loaded or light condition, their immersion is proportionately greater; consequently in heavy weather there is no danger of the engine racing, and the engineer on watch does not have to stand ready to throttle down when the stern lifts.

* Naval architect, 328 Chestnut street, Philadelphia, Pa.

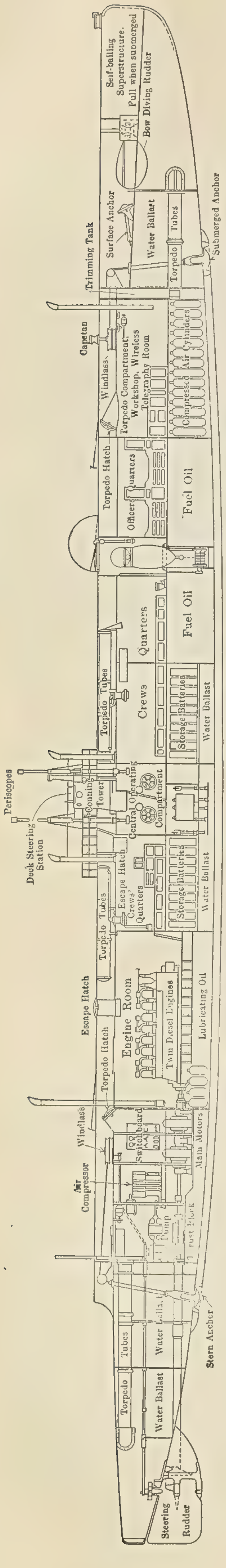


Fig. 2.—Profile of 213-Foot Submarine, Equipped with Special Life-Saving Device

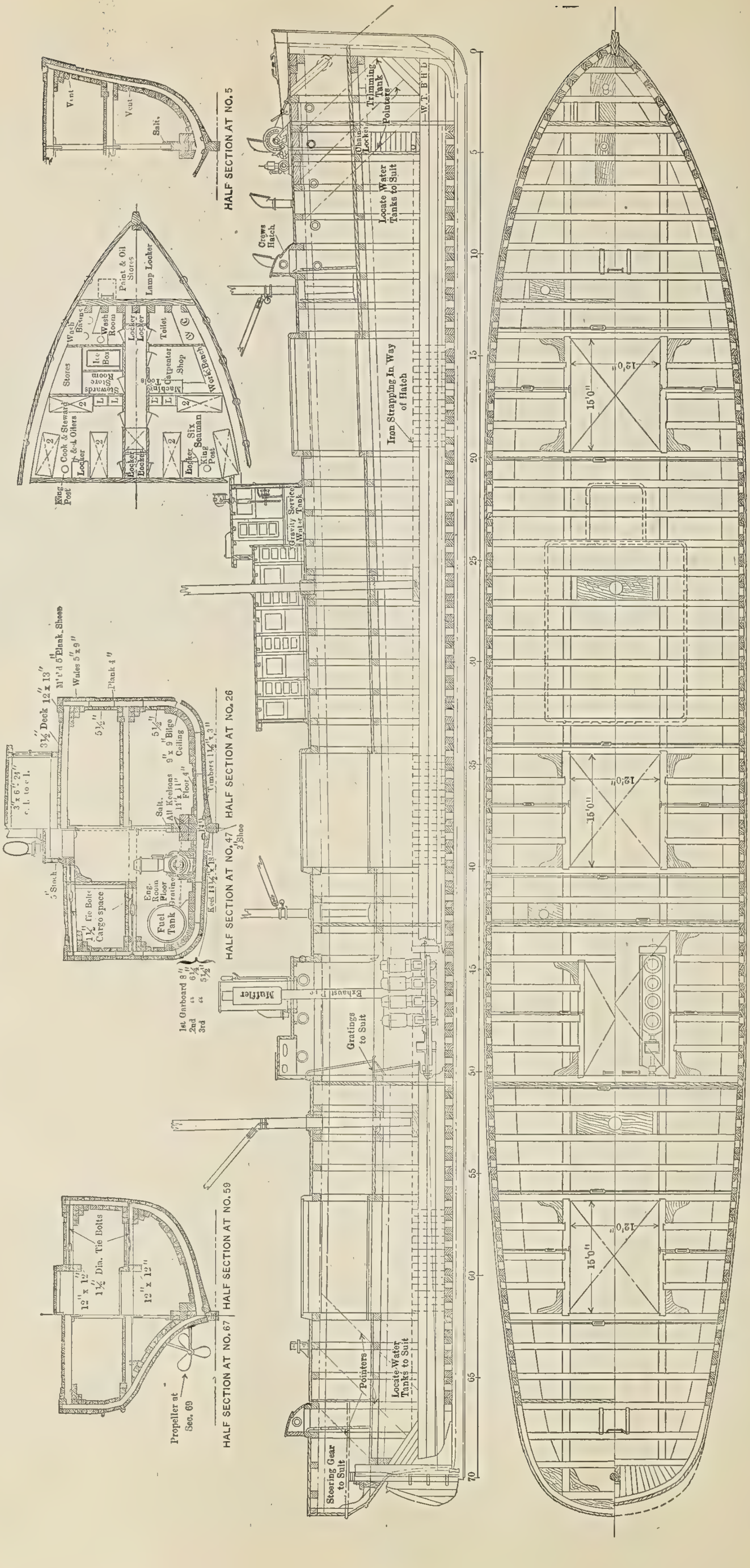


Fig. 3.—Construction Plans of 200-Foot Wooden Motorship of 1,500 Tons Deadweight Carrying Capacity Building for East Indian Trade

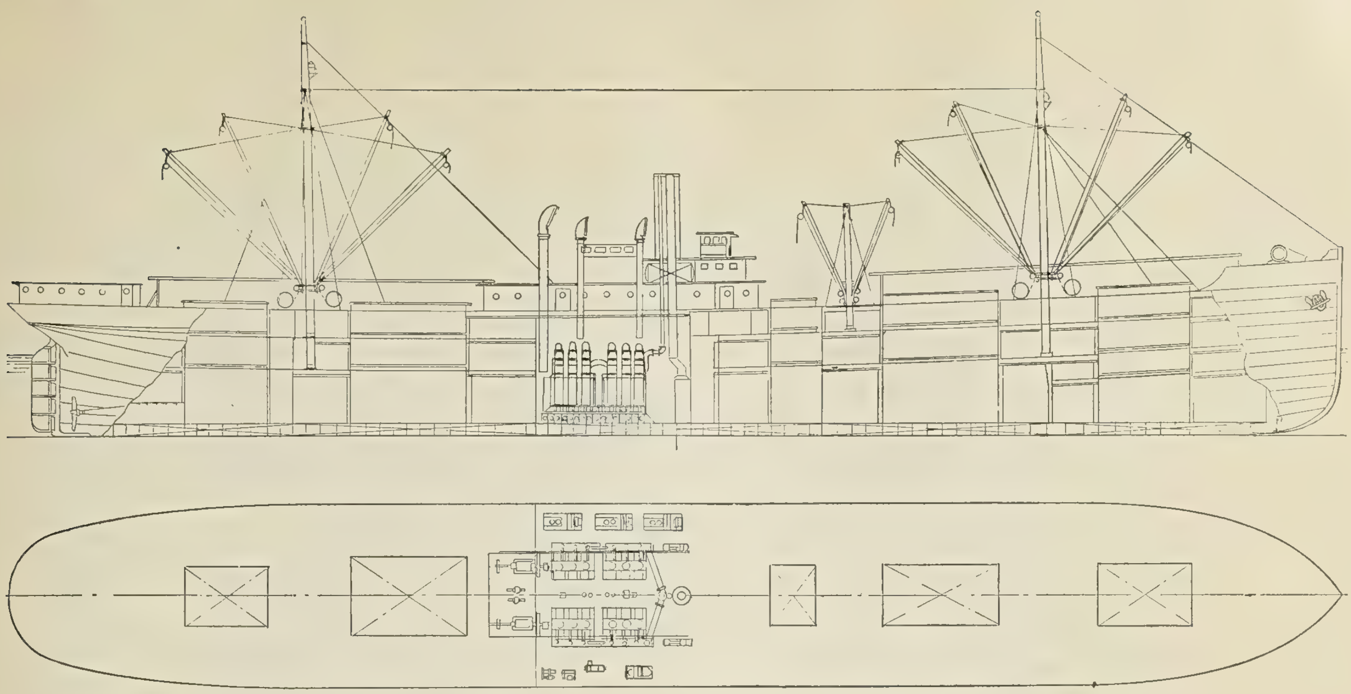


Fig. 4.—Design of Motorship of 12,000 Tons Displacement Propelled by Two 1,600 Horsepower Diesel Engines

On a long voyage the absolute uniformity of the revolutions of the Diesel engines makes up in a large degree for the greater theoretical efficiency of the larger and slower propeller on the steam engine. The saving in weight of the propelling machinery on this size ship is about 129 tons over that of a steamer. The length of engine-room space occupied by the motor installation is 49 feet, about 20 feet less than would be required for the steam plant. According to the latest practice, the fuel oil is carried in the double bottom, and this amounts to nearly 1,200 tons, giving a steaming radius of 29,000 miles. Owing to the saving of machinery space, there is about 20,000 cubic feet saved for cargo over that of a steam vessel, giving an additional earning capacity of about 10 percent. If the steamer burns coal its engineering force would be considerably greater. If the steamer has oil-fired boilers the engineering force would be about the same, as there would be twin engines to look after on a motor ship and a single engine on a steamer. An oil-burning steamer would use somewhat cheaper fuel oil and have less expense for lubricating oil, but the economy in the consumption of the Diesel ship is so great that a saving of about 80 cents (3/4) a mile would be realized on a round trip from Boston to Montevideo, for example, amounting to $9,600 (£1,970).

Wooden Motorships

Owing to the difficulty in getting deliveries of ship plates, many wooden-hulled vessels are being built. Most of the American wooden motorships, a large proportion of which are built in the Southern and Pacific States, have been widely described and illustrated in all the recent marine publications, so I will confine myself to individual types of motor vessels, most of which have been designed for foreign owners. The following plans will illustrate my meaning:

Fig. 3 shows a class of oil-engined wooden cargo vessels, 200 feet long, now building by Pyne, Hughman & Company, Ltd., Calcutta, India, from the author's designs. They will be used in the East Indian trade. These vessels have two full decks and about 1,500 tons carrying capacity. They are being built to Lloyd's highest class, giving them a rating of 16 years, their construction being teak throughout, reinforced with steel cross strapping.

The motive power is furnished by twin-screw engines of 500 horsepower, and a fuel supply sufficient for 4,000 miles. A complete installation of electric and pumping auxiliary machinery is fitted, also a four-ton ice-making machine for furnishing refrigeration in the tropics. The windlass and cargo winches are also driven by oil engines. There are six cargo booms, two on the mainmast and one on each of the four king posts. There are three large cargo hatches, each 12 feet by 15 feet. The accommodations for the crew are unusually good, the officers being berthed in the deck house and the crew in the forecastle. The general dimensions are: length, 200 feet; beam, 35 feet; depth of hold, 17 feet 6 inches.

Shallow Draft Oil and Cargo Motorships

In the January issue of Marine Engineering, page 10, were shown the plans of a fleet of oil tankers for use on the Volga River, building by the Nobel Brothers Company, of Petrograd, Russia. As the Nobel Brothers Company have their own shipyards and their own factories are constructing the Nobel-Diesel engines, they are unusually well equipped for the construction of steel vessels of this type. The great difficulty of navigation on the river Volga is the fact that during periods of low water the deepest draft vessel that can be utilized in certain reaches of the river is limited to 7 feet, and the interesting problem arose to design self-propelled steel vessels of large capacity, with this light draft, that would have a speed when loaded of 12 miles.

The general dimensions are: length, 432 feet; beam, 64 feet; depth, 14 feet, and draft, loaded, 7 feet. The vessels are constructed of mild steel. The oil cargo is carried in bulk in the deep, double bottom and expansion trunk. There are four main propelling engines of the Nobel-Diesel type, each of 750 horsepower, and each driving a three-bladed bronze propeller 80 inches in diameter and 80-inch pitch, at a rate of 225 revolutions per minute, giving a speed of 12 miles loaded, and about 14 miles light. There are three rudders hung outboard, actuated by a Dake steering engine aft, and controlled

from the pilot house forward. Besides the 3,500 tons of cargo in the shape of petroleum in bulk, there are tanks for fifty tons of fuel oil for the main engines and auxiliary engines.

A fleet of motor vessels is also building by the Nobel Brothers Company, of Petrograd, Russia, of even less draft than the oil tankers, which can navigate the shallow tributaries of the Volga. These vessels carry oil in barrels in a large cargo box on the main deck. The oil is brought from the oil fields to the main distributing centers on the trip up river, and lumber and other bulk cargoes are loaded into the cargo box for the return trip. This class of boat is 325 feet long, and on account of the shoalness of the upper Volga River is restricted to 5 feet draft loaded. This vessel carries 1,500 tons of oil in barrels, besides 20 tons of fuel oil. They are quadruple-screw boats driven by four 450-horsepower Diesel engines driving propellers 58 inches diameter and 58 inches pitch, and giving a speed loaded of 12 miles.

Auxiliary Motor Schooners

On page 485 of the November, 1917, issue were shown plans of the four-masted schooner *Dornfontein,* now being constructed by the Marine Construction Company, of St. John, N. B., Canada. This boat is now in frame, and the keel of a duplicate will shortly be laid. The general dimensions are: length over all, 185 feet; keel, 160 feet; beam, extreme, 40 feet; depth of hold, 14 feet; molded depth, 15 feet 8 inches. The vessels are constructed to the latest requirements of the American Bureau of Shipping, and utilize as far as possible the timber available in New Brunswick, the keel being of fir 14 inches by 22 inches, with a 4-inch birch shoe, her timbers being birch below the waterline and black spruce above, sided 11 inches double and molded 14 inches, spaced 27 inches. The keelson consists of three tiers on each side, of 14-inch by 14-inch British Columbia fir. The deck beams are also 14-inch by 14-inch British Columbia fir, spaced 3 feet 6 inches apart.

The planking varies from 7 inches to 4 inches in thickness, the under-water portion being birch and the topsides being 4½-inch black spruce. The decking is of 3½-inch spruce. Practically all the deck joiner work, houses and hatches, will also be of spruce. The masts, however, will be of Oregon pine, the foremast being 25 inches in diameter and the other three masts 24 inches in diameter; all 84 feet in length; the topmasts are 48 feet 6 inches long, and will be of spruce, as will be the other spars, with the exception of bowsprit, jib boom and spanker boom, which will be of Oregon pine. The engine for the first one of these boats will be a 250-horsepower Kahlenberg oil engine. The engine for the second schooner has not yet been dcided on.

The 150-foot wooden auxiliary schooner *Jose Juan Domine,* building by the Valencia Ship Building Company, of Valencia, Spain, for Romani y Miquel, of Valencia, Spain, will be used in trading between Valencia and the Spanish-African colonies, and is adapted for carrying barrels of wine, raisins, etc. She has a cargo capacity of about 450 tons and is propelled by a 200-horsepower Diesel engine. The vessel is built throughout according to Lloyd's requirements, and is rigged as a three-masted schooner. Besides the main propelling engines, there is a complete outfit of auxiliaries, including a 35-kilowatt electric plant, which operates the electric capstan and electric winches. This vessel was illustrated and described in the March issue of this journal, page 91.

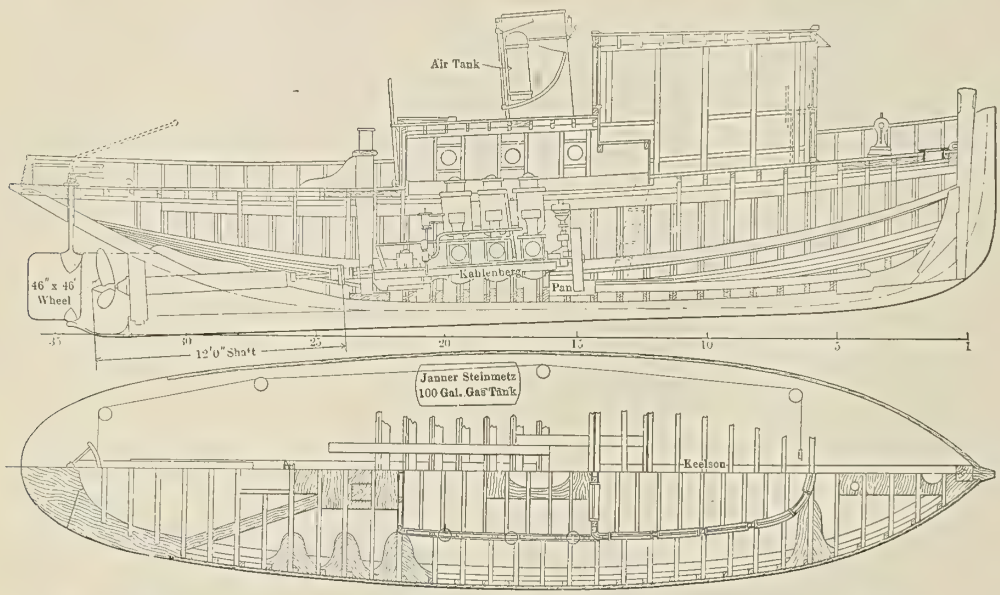


Fig. 5.—Wooden Motor Tugboat Equipped with 90-100 Horsepower Kahlenberg Engine

Motor Tugboats

Fig. 5 is a good example of an oil-engine tugboat. Two of these boats are now being completed at the yard of L. D. Steel, Delanco, N. J., for the Republic Mining and Manufacturing Company, of Philadelphia. Each of these boats is equipped with a 90-100-horsepower Kahlenberg heavy oil engine, which turns a 46-inch by 46-inch three-bladed propeller at 350 revolutions per minute. These boats are intended for the heaviest class of work, being built of oak throughout, and will be used for towing 500 tons of bauxite, which is the name of the ore from which aluminum is taken, in barges from the company's mines to Georgetown, British Guiana, South America.

The general dimensions are: length, 47 feet; beam, 12 feet; draft, running, about 4 feet 8 inches. They were shipped down the latter part of February on board one of the company's steamers. These tugs are an improvement over a similar class of tug recently shipped to Demerara, for the same company, which were also designed by the author, but powered with a 75-horsepower Standard gaso-

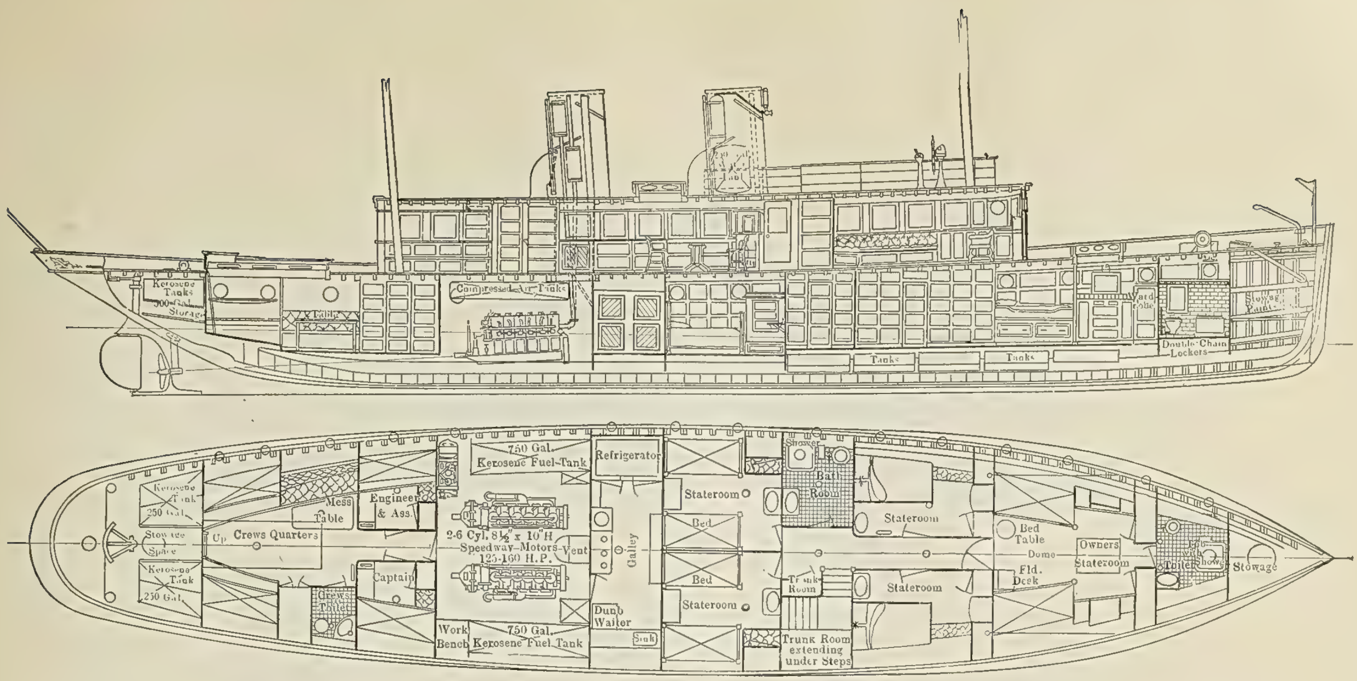


Fig. 6.—110-Foot Oil-Engined Yacht *Consuelo*, Recently Built to Author's Designs

line (petrol) engine. This engine was also equipped for burning kerosene (paraffin), but, owing to the high price of gasoline (petrol) and kerosene (paraffin) in South America, it has been decided that the tugboat fleet for this company shall in future use heavy oil engines, which can use the local fuel oil and effect a great saving in running expenses.

A combination freight and passenger boat now greatly used in South America is the *Sinu,* a 95-foot, shoal-draft, working boat (see page 487, November, 1916, issue), which has been built by the Cartagena Shipyard, from the author's designs, for Mr. F. A. Scharberg, of Cartagena, Colombia, S. A. The dimensions are: 95 feet over all, 90 feet waterline, 20 feet beam and 4 feet 6 inches draft. The engine consists of a 100-horsepower, heavy-duty Bolinders oil motor. The boat is used for transporting cargo and passengers up and down the river from Cartagena, Colombia. There is a good-size saloon for passengers in the deck house and plenty of room for cargo in the forward and after holds.

Fig. 6, the 110-foot cruising yacht *Consuelo,* is a good type of oil-engined yacht. This boat was recently built by Geo. Lawley & Son Corporation, Neponset, Mass., for J. Percy Bartram, of New York. The general dimensions are: 110 feet over all, 102 feet waterline, 21 feet beam, and 5 feet 8 inches draft. This boat shows the general tendency of the large motor yacht to get the accommodations of a houseboat with the seaworthiness and shippy appearance of a seagoing vessel. The engine room is just aft of amidships. In it are installed two 160-horsepower Speedway oil motors, a 4-kilowatt electric plant, the auxiliary plant, tanks holding 2,200 gallons of fuel and 100 gallons of lubricating oil. The crew's quarters are unusually spacious, there being bunks for five paid hands, and a mess room, crew's toilet and two staterooms, one for the captain and one for the mate and engineer.

Concrete Motorships Being Designed

Owing to the difficulty of obtaining material for the usual form of ship construction and the scarcity of skilled ship carpenters, a new type of craft is now being tried out in the oil-engine field, and this is the concrete vessel. Fig. 7 shows the general arrangement plan of a fleet of inland waterway motor-propelled freighters now being designed by the author for a New York shipping firm. These boats are 150 feet long, 21 feet beam, and have a draft when fully loaded of not over 6 feet, so as to enable them to go through the Delaware and Raritan Canal. They are propelled by 60-horsepower Mietz & Weiss oil engines. The freight is carried on deck and is brought aboard by

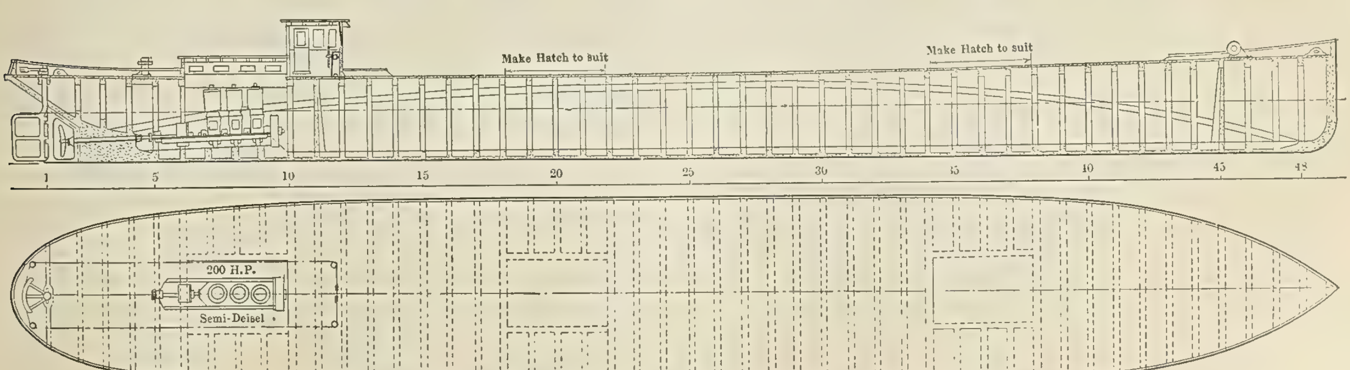


Fig. 7.—Reinforced Concrete Motor Freighter. Length over all, 150 Feet; Beam extreme, 22 Feet; Beam molded, 21 Feet; Load draft, 6 Feet

means of trucks. For this purpose the deck is kept absolutely clear, except for the power windlass forward, and the pilot house and engine room trunk aft.

The chief advantage of these boats is that they only require between 35 percent and 40 percent of the amount of steel used in a steel vessel of equal carrying capacity. Their disadvantage is that the weight is about 80 percent greater for seagoing vessels and about 65 percent greater for canal work and use in sheltered waterways. Through the employment of a rich mixture of cement and suitable waterproofing material, the hulls can be kept practically impervious to water. From an engineering point of view, the main structural strength in tension is taken up by round bars of steel, which vary from ½ inch to 1¾ inches in diameter, embedded in the concrete, the power of adhesion between the steel and concrete being increased by the irregularities of the bars. The stresses in compression are largely taken up by the concrete itself.

Owing to the greater weight of the concrete hull, it would naturally seem that considerably greater power would be needed to propel them than with the lighter steel hull. Part of this loss is offset by the fact that the surface of the concrete can be finished smoother than the steel hull, and also very good lines can be easily given these vessels, together with the absence of the box-like, parallel middle-body so often employed with steel shapes for the sake of economy in framing and plating and ease in construction.

This covers pretty thoroughly the present state of the art as applied to motor vessels, but there is no doubt that after the war we will have a very rapid development in the size of Diesel engines, so that eventually they will be employed in the largest type of ships. In Germany, before the war, some very large experimental engines were constructed at the Krupp Works, one of them developing as much as 1,500 horsepower in a single cylinder. Considerable difficulties were experienced from the intense heat causing internal stresses in these large castings, but when these difficulties are overcome it is easy to see that a six-cylinder engine of this type would develop 9,000 horsepower or 18,000 available horsepower for the ordinary type of twin-screw ship.

American Classification for American Ships

Regulation of Shipbuilding and Insurance of Vessels Must Be in American Hands to Preserve Our Merchant Marine

BY WINTHROP L. MARVIN

A SPECIAL committee on merchant marine of the Boston Chamber of Commerce, in a recent report addressed to the Senators and Representatives in Congress, emphatically set forth as "one essential of complete success in American shipbuilding and navigation," "a thoroughly American inspection, survey and classification service, capable of performing for the United States a work which Lloyd's has long rendered for the British Empire."

Now the time has come for a vigorous reassertion of this fundamental truth that the new American merchant marine which the emergency of the war is creating will inevitably fail of its ultimate purpose and decline and disappear from beneath our flag, if the regulation of our shipbuilding and the insurance of our ships are to be left to alien concerns pledged to promote the interests of other peoples and of other governments. As this Boston report declared:

"For many years American shipowners and merchants, even in the coast and lake trade, have been largely dependent for marine insurance upon foreign corporations. To realize the full benefits of an independent American shipping industry, it must be possible to effect adequate insurance in companies domiciled in the United States, preference being given by our shipowners and merchants to insurance in American companies, and to this end a strong classification society must be at once established, so that American insurance interests can undertake marine risks with all proper safeguards and necessary information. There is abundant capital in this country, and abundant technical and administrative skill, and they should be brought into effective co-operation."

During the earlier years when American sailing clipper ships and steam mail lines were pre-eminent in ocean traffic and the Stars and Stripes flew on all seas, our country was not beholden to any foreign land for its marine insurance. Satisfactory inspection and underwriting were available in our own land; in this most vital element of maritime strength we were prepared and independent. The Civil War, and the ravages of the Anglo-Confederate cruisers—built, fitted out, largely manned in England, as history records—dealt a heavy blow to our resources in this direction.

How Our Underwriting Was Lost

Gradually, as we lost most of our merchant ships, our insurance resources shrank and vanished with them. Or, as a veteran observer has described it:

"The United States has fallen behind in underwriting, not for the want of capital, but because Amerian insurance business has been undermined through the decay of our marine and the consequent extinction of American mercantile houses and genuine American commerce with foreign nations. It cannot be expected, as a practical thing, to have underwriters without merchants, merchants without ships, and ships without shipowners and builders, as these branches all belong to the same tree. When you admit a foreign merchant, you let in his ship, his underwriter and his shipowner, and there is a great growl by all his friends, new as well as old, because the door is shut to his shipbuilder; for his desire is to employ all his own people, in preference to ours, even after he has grasped, and controls, our trade."

Origin and Power of Lloyd's

All of this is true, as all men know who know the past course of American shipbuilding and navigation. Nearly a century ago, in the year 1834, a committee of British shipowners and underwriters, men of a class whose historic rendezvous had been Lloyd's coffee house in London, agreed "to establish a new society for the purpose of obtaining a faithful and accurate classification of the mercantile marine of the United Kingdom and of foreign vessels trading thereto." There can be no objection to a "faithful and accurate classification," but as Lloyd's grew

in scope and power this is just what it has not given to the ships of Britain's most enterprising and most feared competitor.

The influence which British inspection, survey and insurance laws and methods have had upon the American merchant marine has been adroitly and persistently unfriendly and repressive, and it would be the height of national folly to permit this to continue when the time and the occasion have now come to put an end to it forever. The great American shipbuilder and shipowner is now the Government of the United States—the greatest shipbuilder and shipowner in existence. The largest fleet owned under any single corporate control in Europe is a pigmy besides the 9,000,000 tons which the Federal Shipping Board has requisitioned or is constructing. But under the law creating it the Shipping Board is holding this huge merchant fleet only temporarily, as a trustee for the American people, with the avowed purpose of transferring it to citizen owners to be operated by private enterprise as soon as possible after this present war has ended. And the Shipping Board is under obligation to arrange for the inspection and insurance of these hundreds of American ships in such a way that after the war they can remain under the American flag as carriers of peaceful commerce.

They will never so remain if the classification which they will bear and the rate of insurance required—which practically fixes the freight rate they can command, and, indeed, determines whether they can obtain cargoes the world around—are to be left to the whim of men or organizations of the nation which will certainly be our chief antagonist. The vast power of Lloyd's encircles the globe. Great Britain has controlled five-eighths of the carrying trade of the world, but monopolizes seven-eighths of the sea insurance, and has a record of wielding this tremendous weapon relentlessly for her own advantage.

Let Us Learn From Experience

Let us turn back to some illuminating chapters of our own maritime experience. Those British-built "privateers" of our Civil War, as has been said, struck American ocean shipping a hard blow, but did not kill its spirit of enterprise and perseverance. When that war closed, subsidized British mail lines securely held nearly all the chief trade routes of the world, and the speed of our clipper sail ships could not prevail against them. But there were still some long-voyage trades where passengers were few but cargoes heavy and valuable, which steamers could not yet undertake. One of these, and the principal, was the export trade of grain from the fertile States of our Pacific coast to Europe.

There was then no Panama Canal or Tehuantepec isthmian railway; the route lay around Cape Horn, and it was a voyage of 13,000 to 14,000 miles, or four or five months, from Puget Sound, the Columbia River and the Golden Gate to Falmouth, Queenstown, Liverpool, Havre or Antwerp. Grain was a bulky, shifting, hazardous cargo, and the character of this commodity and the length of the run compelled the use of large, strong, seaworthy vessels, the best carriers of the chief maritime nations of the world.

The Great California Grain Trade

It was not a trade for steamships; the distance was too great and the cost of coal too high. It was the special field of the great square-rigged ships and barks of a substantial type, which had succeeded the clippers of an earlier generation. When the Civil War was over, the shipbuilders and shipowners of New England and New York, undaunted by their losses, laid the keels of a new fleet of the finest wooden sea carriers that ever floated. Stancher and more durable than the flying racers of the two decades before 1861, they were powerfully constructed of the best of oak and hard pine, on models less sharp and extreme and yet symmetrical, skillfully combining great cargo room with unusual speed. These were the "medium clippers," the characteristic deep sea American sail ships of the period from 1865 to 1890. They were built for the California grain trade and they were of far more than average size, ranging from 1,200 to 3,000 tons gross register.

They embodied a new challenge to the maritime asendency of Great Britain. How were they met—in a spirit of free and equal competition? Not at all. The British Lloyd's struck them an unfair blow almost at once by arbitrarily refusing, in 1870, to "class"a wooden ship for more than a year at a time, and Lloyd's Register and the British underwriting companies combined to discriminate most unjustly against these splendid new American square-riggers and to drive them from the ocean.

Our Ships Largest and Best

All the details cannot be related here. It was a sharp struggle and a long one, graphically set forth in several chapters of that painstaking work, the "American Marine," by the veteran Captain William W. Bates, former United States Commissioner of Navigation. Captain Bates tells how in the seventies and the early eighties Americans and Britons fought for the mastery of the California grain trade, and around-the-Horn trade, the noblest field of maritime rivalry and the severest school of seamanship. Of the American competitors a few were of iron; most were of wood. Of the British craft nearly all were of iron. The Americans were, as a rule, the largest vessels, averaging between 1,600 and 1,900 tons, while of fourteen great ships of above 2,000 tons that sailed from the coast for Europe in 1880-1881, twelve were New England-built. The average tonaage of the British iron ships was less than 1,400.

From a close analytical study of voyages, Captain Bates shows that the American ships in this Pacific trade bore off all the honors of actual performance. They made their passages around the Horn to Europe in time averaging five days less than the British iron ships. The Americans met with fewer accidents and called on the underwriters for fewer losses; only one American vessel out of 212 was wrecked, while of British vessels the record was one out of 88. The American ships delivered their valuable cargoes in the best condition. On the basis of actual achievement, the American grain fleet in those years of memorable rivalry should have had the lowest insurance rates and the highest freight rates. That was incontestably the due of the Stars and Stripes, as established by our incomparable builders and seamen.

How American Ships Were Driven Out

As a matter of fact—Captain Bates relates the whole story—the British Lloyd's Register and the British underwriters in collusion for the upholding of British interests at any cost, forced the American ships to pay the highest insurance rates and to accept the lowest freight rates, the discrimination amounting at times to more than 20 percent. These cargoes of American grain were sold principally to British merchants and ships and cargoes were insured in British companies—there were relatively few American underwriters on the Pacific coast. Thus a deliberate and hopeless handicap was laid upon American shipping, and gradually these splendid vessels, in the prime of their strength and efficiency, were driven by the

tyrannical power of Lloyd's from European trade and forced to seek shelter in the protected coastwise service.

In the period from 1881 to 1885, one hundred great American ships had sailed every year in the grain trade from San Francisco to the United Kingdom or the Continent. In the year 1889—so well had Lloyd's done the work expected of it—only 30 American ships sailed in this trade, as against 167 British vessels. Though the American ships were compelled by Lloyd's discrimination to accept a freight rate 15 percent lower than foreign ships, the 30 Americans made the long voyage to Europe in an average of 113 days, as compared with the 131 of their favored British competitors. In that year, 1889, only one square-rigged ship was built in the United States; Great Britain still had hundreds of large sail craft afloat. A surer way than the *Alabama's* had been found to destroy American ocean commerce, and that long before steam had come to dominate Pacific carrying.

When, some years later, an American shipbuilding concern on the Delaware River sought to send machinery from Wilmington to Puget Sound to establish an iron shipyard and machine shop there, both the machinery itself and the steamer that conveyed it were denied insurance by the foreign underwriters—their mastery of the situation had become almost complete.

A Sinister Alien Monopoly

Well does Captain Bates declare:

"Foreign underwriters do, and always will, prefer to cover the commerce, and serve the interests, of their fatherland. Partiality goes with their allegiance. As clever rivals make unfit agents, so foreign underwriters cannot equally serve two nations. No wise nation will commit its commerce to the insurance powers of rival countries, because to trust foreigners, in place of our own people, is to be betrayed at last. We may as well have our shipyards closed, as our insurance offices shut up, since we should expect the same result to follow, namely, helpless foreign dependence in a vital branch of business. It is needful to know only the history of their hateful grasping of our trade and transportation to understand fully, if we become dependent on the British Lloyd's or other English underwriters for marine insurance, on that day our competition with British shipping is at an end."

This whole question of classification and survey and of marine insurance has now come again to be a very live question with the American people and their government. We have a record of what the British Lloyd's and British underwriters have once done, and they will do the same thing once more if we are blind and infatuated enough to give them an opportunity. Lack of knowledge of the past, or a most deplorable lack of caution, has admitted Lloyd's to a part in the inspection and classification of the new steel ships now building in this country for the United States Shipping Board. Some of these vessels were ordered for foreign owners, but have now been taken over by our government and are destined to fly the Stars and Stripes. There can be no possible excuse for a continuance of any control over these government-owned American ships by a wholly and intensely foreign organization like the British Lloyd's, or for the surrender to it of any supervision whatsoever over new American ships yet to be constructed.

Need of More Wisdom Now

The special committee on merchant marine of the Boston Chamber of Commerce in the report already referred to declared:

"Every important nation which has developed a merchant marine of its own has appreciated the need of creating at the same time a classification and insurance system of its own, instinctively recognizing the unwisdom of depending for such an indispensable service upon the resources of foreign competitors. It is earnestly believed by many American shipowners that the decline of our own mercantile marine was hastened by certain arbitrary discriminations of powerful marine insurance authorities of Europe, and it is the manifest course of prudence to make such discriminations impossible hereafter by providing requisite American standards of construction properly adapted to meet the particular needs of the widely varying types of ships required for American domestic and foreign commerce."

Since these recommendations were recorded, certain well-considered and vigorous steps have been taken by representative American steamship companies and shipbuilding corporations to provide a strong American classification and insuance system. The American Bureau of Shipping, founded in 1862 as the American Shipmasters' Association, has been thoroughly reorganized, with new management and new and powerful support. On its technical committee of advisers are some of the ablest men from American shipyards. The surveying force of the Bureau has been greatly increased; all of the surveyors are American citizens. The Bureau is in a position to add to their numbers as our shipbuilding programme grows. With the extension of the Bureau's service there has come a remarkable strengthening of American resources in marine insurance. Existing concerns have enlarged their field of operations. New concerns have been established. The business has proved to be a profitable one, and it is attracting American capital in such amounts that American shipowners have been more and more successful in securing complete underwriting in the United States. Conditions are such that if the government calls upon the American Bureau of Shipping for its entire survey and classification service the resources for undertaking all of it will be available.

A Thoroughly Unselfish Service

The Bureau holds a unique position for genuinely national patriotic service. It is not a money making organization. It has no capital stock, it pays no dividends. It exists solely for the purpose of providing at cost an indispensable element in the upbuilding of the great new merchant marine of the United States.

Its managers have no quarrel of their own with the old registry society of Great Britain. They recognize that the officers and employes of Lloyd's, as loyal British subjects, are under obligation to serve primarily the interests of the British mercantile marine and the British Empire. As the American Commissioner of Navigation declared in his report for 1890:

"The Society of Lloyd's and the members thereof are the volunteer protectors of the British marine. Leading shipbuilders, managing shipowners, millionaire merchants and rich underwriters compose the society and association. Many members of Parliament are chosen from the classes composing the Lloyd's, and there are always several members of Parliament on the committees which rule the proceedings. The Lloyd's have a policy in all they do. Nothing is undertaken that would be calculated to give foreign ships full equality with British. Leniency toward their own and severity toward foreign ships has ever been their motto. Their weapons are partiality and discrimination. Their rule is by associated action. Their power, derived from the amplitude of their transactions, knows no limit in the shape of commercial inducement."

That the spirit by which Lloyd's is dominated is still the

spirit of old was shown very clearly in negotiations which preceded the reorganization of the American Bureau of Shipping. It was thought for a time that there might be a certain international co-operation, but when the question was definitely put to Lloyd's representatives, whether in case a new design for an American vessel was made in this country, the American committee would have the power to grant a classification to such vessel without sending the plans to London, the answer came right back: "No; the plans must be sent to London for approval!" There and then the negotiations ended, and the American committee unanimously voted to make the American Bureau of Shipping absolutely American and independent of foreign restraint. So long as Lloyd's possessed the power to veto the plans of American vessels it would continue to have the power to choke the development of an American merchant marine in overseas trade.

Thus the American Bureau of Shipping, reorganized and reinforced, embodies a new American declaration of maritime independence. When the Bureau asks for the full sanction and support of the United States Shipping Board and protests, in this hour of great opportunity, against the employment of an alien and hostile classification society to control the construction of American vessels built and paid for with the money of our government, it has a right to expect the friendliest consideration from the authorities in Washington.

It is a good time in shipping, as in other vital national matters, to put none but Americans on guard.

Coal dust or any foreign matter can be removed from the eye by taking a few flax seeds and, after moistening them, placing them under the eyelid and closing the eye for a minute or two. The gelatinous coating of the seed picks up the foreign matter and carries it off.

Some quartermasters handle steering gear without any real sense of its use. One will turn the trick wheel so the engine makes a few revolutions to hold the course, while another will make the steering engine buzz like a flying machine motor. Get rid of this type of quartermaster.

Auxiliary Schooner Building in Texas

THE Tarver Shipbuilding Corporation, Beaumont, Texas, has under construction a three-masted auxiliary schooner, 172 feet long overall, 36 feet beam and 13 feet 6 inches depth, for the builders account. For auxiliary power the vessel is fitted with a 100-horsepower Fairbanks-Morse heavy duty crude oil engine, together with oil tanks for a fifteen days' supply of fuel. For operating the windlass and hoisting the sails a Chris. D. Schramm & Son hoist is fitted, operated by a gasoline (petrol) engine. The poop deck is 3 feet above the main deck with a 3½-foot passageway between the railing and deckhouse. The main cabin has three staterooms, the captain's office and bathroom. The crew's quarters are located on the forward deck.

The hull is built of wood throughout, the keel consisting of 12-inch by 16-inch double long-length timbers. The stem is of live oak 12 inches by 18 inches rabbeted to

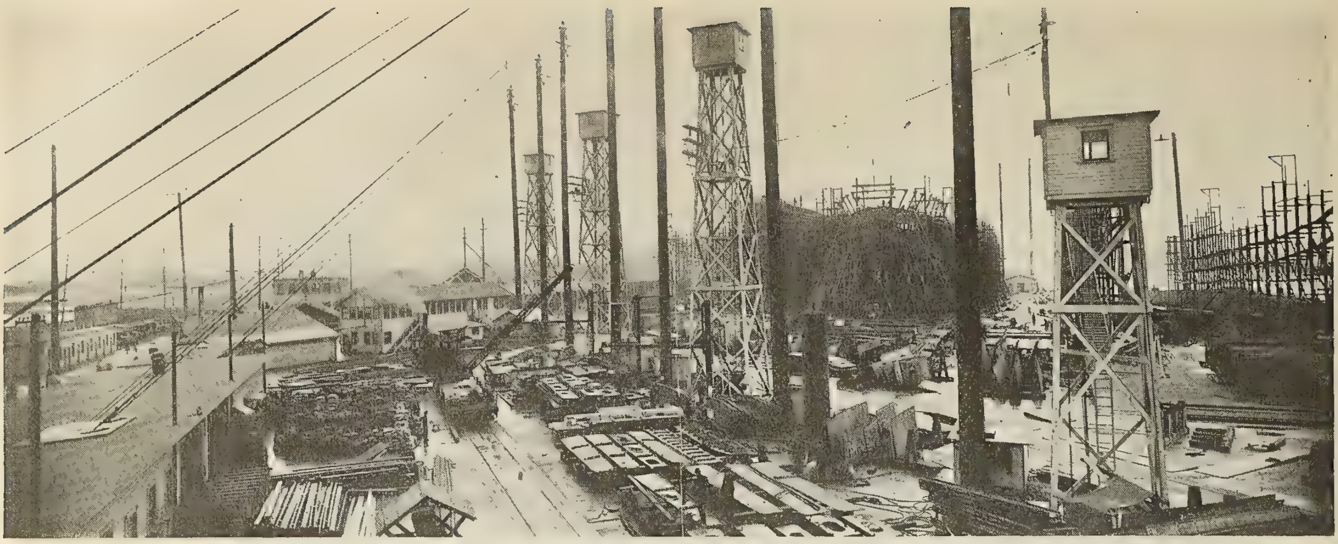
Three-masted Auxiliary Schooner, 172 Feet Long, Immediately After Launching at Yards of Tarver Shipbuilding Corporation, Beaumont, Tex.

receive the ends of the planking. The stern and rudder posts are 12 inches by 16 inches. The center keelson consists of three layers of 8-inch by 12-inch timbers and on each side are sister keelsons of 8-inch by 12-inch timbers, extending to the same height as the center keelson.

The frames are 8 inches by 14 inches double, molded 14 inches on the keel and gradually tapering to 8 inches on the deck line. The first garboard strake is 6 inches by 14 inches and the second 5 inches by 12 inches. The planking from the garboard strakes to the band of the knuckle is 4 inches thick. From the waterline to the deck line the planking is 4 inches by 8 inches. The inside ceiling from the keelson to the bilge stringers is 6 inches by 12 inches and between the bilge clamps and lower shelf strake 7 inches by 8 inches.

The bilge stringers consist of six strakes of 8-inch by 12-inch timbers extending from the apron to the extreme length past the transom. The lower shelving is 10 inches by 14 inches worked to shape and the upper shelving 12 inches by 16 inches.

The deck beams are 10 inches by 14 inches; crowned, 6 inches in 36 feet and covered with 4-inch by 4-inch planking.



One of Seattle's Shipyards (Skinner & Eddy), Where Ships Are Launched in Record Time

Seattle Speeds Up Shipbuilding

Startles Staid Shipbuilders by Swift Construction of Ship-yards and Ships—To Build a Million Tons This Year

IN the last calendar year the four steel shipyards of Seattle and the three yards building wooden ships during the year launched a total of 29 ocean vessels, having a total cargo capacity of 184,800 deadweight tons. Since November 1, 1917, the Seattle shipyards have launched twenty ocean-going merchant ships, sixteen steel steamships of from 7,500 to 12,000 tons deadweight capacity and four wooden ships of 2,600 tons or larger capacity, the total aggregate cargo capacity being 75,000 tons deadweight.

The shipyards of Seattle have building contracts on hand for more than $200,000,000 (£41,000,000) worth of first class ocean carriers, most of them steel ships of standard design and of 8,800 tons deadweight capacity. Eleven steel ships, complete in every detail and almost without exception exceeding contract requirements in their trial trips by from one to three miles per hour, and all without exception receiving Lloyd's classification as vessels of the 100 A1 class, have been delivered to the government since last November.

Seattle Shipyards Entirely New

While the most surprising characteristic in the development of Seattle shipbuilding, especially to the shipbuilders of the old world and the Atlantic Coast, is its unexampled and consistent efficiency, this is explained logically by the fact that all the yards are entirely new, have the most successful modern equipment and are conducted by men who have, before coming to Seattle, been thoroughly schooled in all the technique of the business.

Another unusual feature is the entire harmony of employer and employe, both in the shipbuilding plants themselves and in the auxiliary industries preparing material and machinery for the yards, involving in all approximately 27,000 men. They work together under conditions and wage scales agreed to mutually, and the men in the yards seem to be as enthusiastic in the matter of speeding up production as the owners of the plants themselves.

This admirable and unusual esprit de corps, together with the mild and highly favorable winter climate of the Seattle district, is credited in large measure with the fact that Seattle continues to be the pacemaker in the business of building the big steel carriers for Uncle Sam's new national merchant fleet.

Steel Shipyards

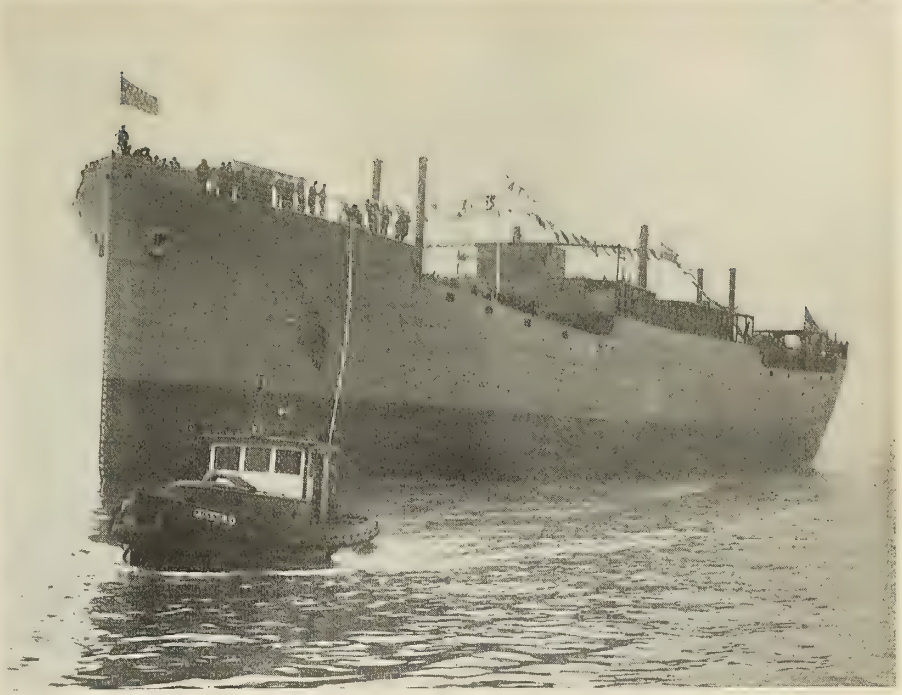
There are four operating steel ship construction plants on the Seattle waterfront, with two others about to be completed, both of which have obtained contracts for steel ships from the United States Shipping Board. The two uncompleted yards referred to are the Patterson-MacDonald Shipbuilding Company's 10-ways plant—five ways for steel and five for wooden ships—and the new plant of the Erickson Engineering Company, with five steel ship ways, and which recently closed contracts with the Shipping Board for the construction of ten 9,400-ton steel merchant ships.

One year ago there were but five ways in Seattle's shipbuilding industry for the construction of wooden ships. Now there are forty-seven ways in the wooden shipyards of the city. Wooden ship construction has this advantage in Seattle, and the Puget Sound district, that all its material has its origin in the immediate vicinity of the yard, for the finest ship timber in the world, as well as the best airplane timber, comes from the forests of western Washington and Oregon—Douglas fir and Sitka spruce.

S. S. Seattle Built in 78 Working Days

The outstanding achievement of Seattle shipyards is the accomplishment of the Skinner & Eddy Corporation's plant in producing the 8,800-ton steel steamship *Seattle* complete in 78 working days. The *Seattle* was built under the 84th contract awarded by the United States Shipping Board, and she was the first direct contract vessel of the emergency fleet launched in the United States, being launched November 24, 1917. Less than a month later,

December 22, the same yard launched another 8,800-ton steel ship for the Shipping Board, the *Absaroka,* thus finishing its first year in which its plant had sent 100,400 tons deadweight of new cargo carriers down its ways. The latest launching by this yard was on February 27, when the 8,800-ton steel steamship *Canoga* was sent down the ways for the Emergency Fleet, and at the same time the steel steamship *West Arrow,* 8,800 tons, completed her trial trip, exceeding requirements, and was delivered to the government, all within three hours, being the eleventh complete steel ship delivered to the government by this one plant.



S. S. *Seattle,* the First Direct Contract Ship Finished for Uncle Sam. Launched at Seattle on November 24

How the Record Was Made

The complete equipment of the Skinner & Eddy plant may be largely responsible for the wonderful building performances of this yard, but among Coast shipbuilders, the superior skill and executive ability of General Manager David Rodgers, and the economic and efficient system of operation which he has established and maintained are chiefly credited with the great record. Moreover, the Skinner & Eddy Corporation, like most of the Seattle yards, has always met the just demands of its employes, or in most instances anticipated them, so that it has never experienced the least spirit of dissatisfaction or unrest among its skilled or unskilled men. Indeed, the men exemplify loyalty and enthusiasm in their work at all times. Mr. Rodgers has perfected what might be termed a fabrication of all parts of a ship. That is, he consistently maintains a method of supplying finished material for any part of a ship under construction, piled up ready for use, exactly at the point of installation, and this method has been perfected at this plant to such fine detail, that the first plate, shape, bar or bolt required is always on top.

Perhaps the least understood problem of Seattle shipbuilders, so far as their Eastern brethren are concerned, is the question of supplying steel from such great distances, for all of it comes from more than half-way across the continent. It was amazing, and indeed inconceivable to Eastern shipyard men, when the Seattle steel shipyards, so remote from the source of steel production, picked up the American shipbuilding speed and efficiency banner and retained it consistently ever since the beginning of the Emergency Fleet Corporation's building program. The Seattle yard managers explain this by stating that in nearly every case they have anticipated construction many months in advance, and have ordered their steel supply accordingly.

Builders of the Battleship Nebraska

The splendid plant of the Seattle Construction & Dry Dock Company, which is the pioneer steel shipyard of the Pacific Northwest, and which in 1905 launched and completed the only battleship ever built on the Pacific Coast north of San Francisco, the battleship *Nebraska,* which later made the famous 15,000-mile trip around South America to join Admiral Schley's squadron in Cuban waters, rivals the Skinner & Eddy plant in size and production capacity, each of these yards employing more than 5,000 men. On December 19, 1917, the Seattle Construction & Dry Dock Company launched the 12,000-ton steel steamship *Walter A. Luckenbach,* commandeered by the Shipping Board, the largest steel vessel ever built in the Pacific Northwest.

Auxiliary Powered Schooner *Ypres,* Launched at Seattle, January 18, Proceeded on Her Maiden Voyage and Trial Trip Immediately After Launching

The two other steel plants now building vessels for the government in Seattle are those of the Ames Shipbuilding & Dry Dock Company, equipped to build and install everything required in steel ship construction, including engines, boilers and steering gear,

and J. F. Duthie & Company, also a completely equipped yard, both of which have remarkable records of speed and first-class construction. The Ames plant, whose site was idle mud flats less than a year before, launched its first steel ship of 8,800 tons cargo capacity November 24, 1917. This was the steamship *War Brigade,* commandeered on the ways, when under construction for the Cunard Steamship Company, by the United States Shipping Board, and renamed *Westerly,* now in active service for the government. President Edgar Ames, of this company, by the way, is recognized as the creator of Seattle's present waterfront industrial district, having spent eighteen years of his life in the work of financing and directing the reclamation of 25,000 acres of idle tide land, comprising all that shore front district south of King street and the wholesale center.

Duthie Yard

The J. F. Duthie & Company yard, antedating the Ames plant by but a few months, completed three 8,800-ton steel steamships in 1917, two under contract for the Cunard line and one for Peter Kleppe of Norway, all commandeered by the government and renamed *West Point, Westfield* and *Westward.* All of these vessels exceeded their speed requirements and received Lloyd's classification of 100 A1. This yard is now averaging one launching per month.

With this successful start the Duthie yard gives every promise of setting new records in Seattle shipbuilding.

Seattle Yards to Deliver 1,000,000 Tons Deadweight in 1918

The shipyards of Seattle, so far in the new year, have averaged one 8,800-ton steel steamship complete, every eight days, and have undertaken to build and deliver complete to the government Emergency Fleet Corporation, an aggregate of one million tons deadweight cargo capacity of new steel and wooden carriers of the first class within the present calendar year. This is obviously a big order for these new yards, but the output of one wooden and eight steel steamships in the first two months of the year, with only four of the six steel shipbuilding plants in full operation, has convinced critical observers that target is easily within range, and that before the opening of summer the Seattle yards will be turning out, complete, about 10,000 tons of new cargo capacity per week.

Seattle's Forging Plant

A most important addition to the shipbuilding facilities of Seattle is a complete steel forging plant now in operation, the only plant of the kind west of the Mississippi river, which is now supplying steel stern frames and stems to the big shipyards of the North Pacific Coast and has furthermore already undertaken large construction work for Oregon, California and even East Indian shipyards. This forging plant, therefore, has brought a practical solution of one important phase of the steel problem with which the Coast builders have had some difficulty and delays.

Seattle's New War Industries

Shipbuilding and Airplane Manufacture of First Importance—Full Capacity Not Utilized by the Government

BY CHARLES PHILIP NORTON

WHILE Seattle's records for rapid building and delivery of ships stand alone, Seattle is much disappointed, because the Government is not making greater use of its peculiar advantages for producing war supplies. Instead of building one million tons of new ships, the Seattle yards claim to be able, with Government co-operation in providing steel and labor, to produce this year three million tons. Instead of building fifty airplanes, as at present, Seattle has materials and labor for the production of 5,000 machines this year. Instead of having 28,000 men employed in war industries, Seattle would keep 100,000 busy for winning the war.

Vanguard of 10,000 Skilled Workmen Mobilized for Building Ships at Seattle by the Government

Young Women of Seattle Are Taking the Places of Helpers and Young Mechanics Who Have Gone to War

With plenty of coal and assured deliveries every month in the year; plenty of the cheapest hydro-electric power; the most efficient labor, and a climate which permits men to work outdoors the year round, Seattle claims matchless industrial advantages. As for the climate, there has been no time lost on account of cold, storms, or extremes of any kind. The residents were mowing their lawns and clipping roses outdoors in January, when the Eastern people were shivering in zero temperatures.

Most of the spruce for airplane manufacture is being supplied by Puget Sound, but somehow the Eastern manufacturers have neglected Seattle as an ideal place for the location of branches and the raw materials are sent East. During the month of January, 260,000 tons of raw materials arrived at Seattle from the Orient, and capacity cargoes were returned.

Washington, D. C., recently was flooded with appeals to co-ordinate its work by having emergency contracts filled at Seattle, rather than permit disaster because of industrial paralysis east of the Rockies. Urgent appeals also were sent broadcast for manufacturers to establish branch factories in Seattle. The argument was that this not only would assure victory in the war, but would enrich the manufacturers after peace is restored.

The Seattle business men disclaim greed for war profits. They are concerned most in national triumph, saying: "Our money will be worthless, if we lose the war." They also point to what they call a certainty, that the trade with Siberia, the Orient, and Alaska, after the war, will be great enough alone to make Seattle a world metropolis, and that the city, therefore, does not need to advertise its resources to gain any advantage in business or population.

The Government is co-operating to the extent of employing 10,000 additional skilled shipyard workers for Seattle, who are to be "on the jobs" within the next ninety days. The first contingent arrived January 20. The men were received with public honors. Homes had been provided for them. Accommodations for future arrivals are now being prepared. Seattle has solved its first housing problem.

All serious labor trouble has disappeared in the Pacific Northwest. The I. W. W. agitators are now at work and organized labor is co-operating efficiently with the Government.

Seattle's records have been made possible, in part, through the efforts of thousands of patriotic women, young boys, girls and wealthy men beyond military age. They participate in certain lines of work by taking places vacated by young mechanics and helpers who have gone to war. Through them every available man, having any knowledge of machinery, is released for service in the great shipyards. In this way, Seattle is one hundred percent efficient in war work for all, and is doing its part towards conserving the trade facilities between this nation and the world.

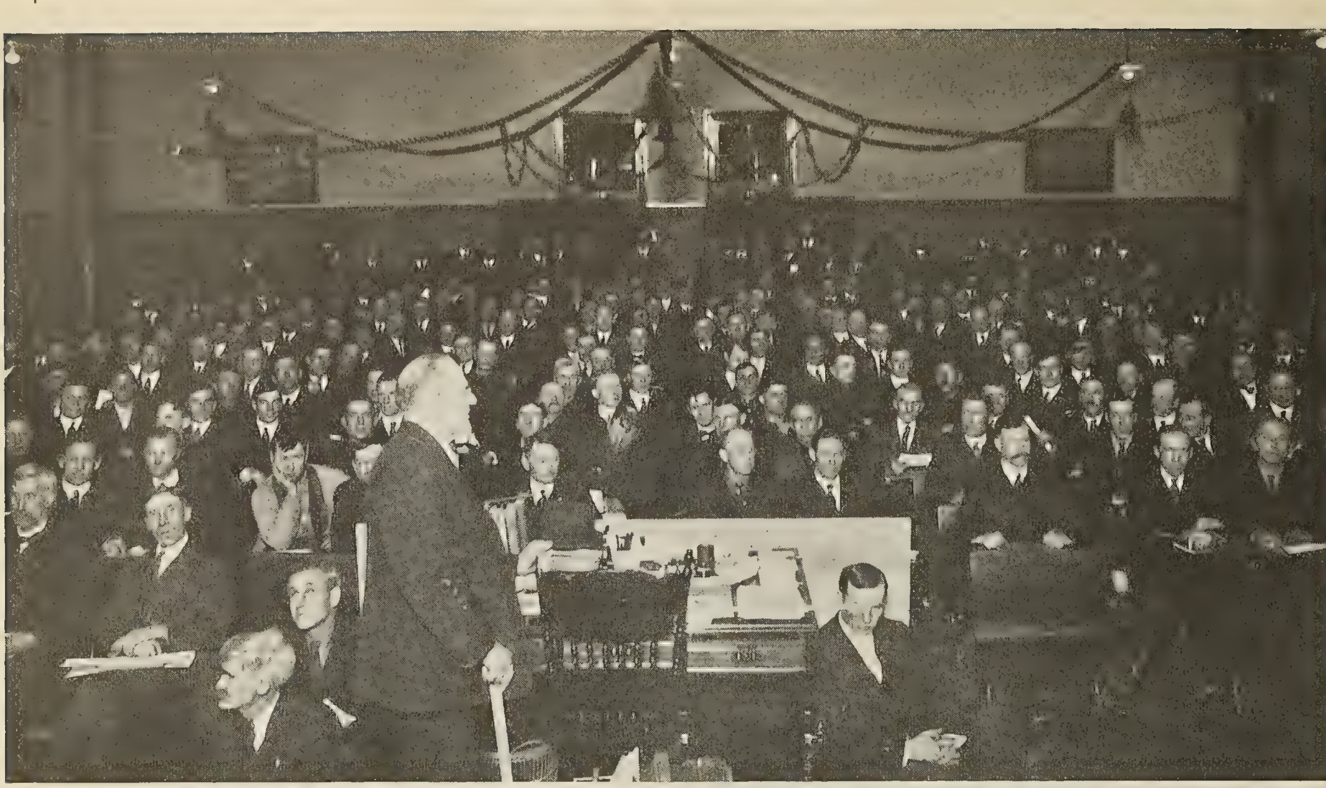
Girls, Elderly Men and Boys Aid in Work

The rapid manufacture of radio outfits for 250 government vessels and many private merchantmen is regarded as of vital importance. The president of the largest plant recently tried the experiment of giving young women a chance to show what they could do as helpers to mechanics. Many of them soon showed such mechanical ingenuity and natural skill that they promptly were promoted, without regard of sex, to the operation of turret lathes, each of which does the work of seven ordinary engine lathes; punch presses, power drills, etc. This plant now employs about 100 girls and a great many more are to be put to work.

The young women, of course, cannot do the work of expert machinists, who devote years to experience and special training, for much of their work requires finishing of the utmost mechanical finesse, down to the ten thousandth part of an inch.

"Before America entered the war we were able to get plenty of young men from the colleges and schools," said the president of the company, "but so many of the boys have gone to the front that we were forced to the conclusion that the girl-in-overalls offered the only solution of our labor problem. They are doing wonderfully well indeed—doing their bit for the national cause."

While the women are filling in on jobs for which they are adapted, thousands of mechanics of the building trades are learning the A-B-C of shipyard work. More than 500 carpenters, for example, enrolled within a week for an instruction course, under patronage of the Federal Government. The school was established by the



Hundreds of Carpenters and Other Skilled Mechanics Attending a Shipbuilding School in Seattle

carpenters' union, with the co-operation of the school board and the federal experts. Interest is so great in the shipbuilding course that hundreds of others will enroll as facilities for instruction are added. The United States Shipping Board assigned, as instructor, Captain W. W. Varney, a veteran shipbuilder. He recently established at Tacoma what he says is the first really practical school for shipbuilding in America, where he is now training 250 mechanics. The Seattle school is the second of its kind in the country, Tacoma's being the first.

Carpenters Resume Their Schooldays

Captain Varney starts classwork with the rudiments of shipbuilding. With the aid of a blackboard, he builds a ship from the keel up, before the eyes of the eager class. The students are all mechanics, most of them skilled in house carpentry, whose last previous experience of school was fifteen to fifty years ago. They know all about tools and how to use and care for them, but most of them are unfamiliar with even the names of the various parts of a ship.

Late in 1917, the official announcement was made that two more large steel shipyards were to be established immediately, to build vessels for the Emergency Fleet Corporation, and that these yards, together with the development of existing plants and of auxiliary manufacturing establishments, would require the employment soon of twenty thousand additional skilled mechanics. The government proposed to employ the workers wherever they could be found, without conflicting seriously with the interests of their present employers and to bring them to Seattle as fast as needed. They were recruited from non-essential industries. Federal officials met with the war shipping committee of the Chamber of Commerce and Commercial Club and advised that the problem of housing the newcomers be solved at once.

Roused by this challenge to the Seattle spirit, the Chamber immediately began work on a house census, in which the postoffice employees and mail-carriers assisted, and devised plans of utilizing all vacant buildings suitable for dormitories for bachelors. After developing for use all existing facilities for housing the mechanics, whose families also arrived in large numbers, the work of building new cottage homes began. The "own your home" campaign is now under way. This will be, perhaps, the greatest house-building programme in the history of western cities, and it must be completed within ninety days. Patriotic architects are offering free services. The committee workers declare it shall be done and all creative forces at the disposal of the Chamber are being coordinated for the work.

Absolute harmony of effort is maintained, including the services of union leaders. The general aim is to absorb the thousands of newcomers into the city's permanent industrial population. If this is done, as the committee workers declare it will be, Seattle will have a mighty population of highly trained mechanics. If the war should end in the spring, 'tis said, the Seattle shipyards have enough contracts now to assure a continuance of double-shift activity in all of the shipyards for at least one year.

The city-builders are advised, however, that the end of the war will mark the beginning of an even greater shipbuilding programme. America's merchant fleet, to be given preference, will require a complete overhauling. Every vessel afloat to-day will be in need of drydock repairs. Hundreds of new ships will be needed to round out the Nation's cargo-carrying fleet—one for the Pacific and one for the Atlantic, and one especially constructed for the coastwise trade. Besides the needs of America, every country in Europe will want ships and the demand will continue unabated for many years.

A "cuss word strainer" on the voice tubes to the engine room would be a salable article. It might sell also to the telephone companies. Some genius should get after the idea.

Magnesite Composition Decking

What It Is—How It Is Manufactured and How It Should Be Applied — Specifications

BY G. W. SELBY*

"WHAT decking material to use" is a question occupying a prominent place in the minds of those responsible to humanity for delivering the largest number of ships in the shortest space of time ever allotted for such a gigantic task. The principal factors entering into the decision may be stated in the order of their relative importance as follows: Merit of material, availability, time for installation, and cost of installation and maintenance.

The material which is to be considered, above all others, as meeting the foregoing requirements is magnesite composition decking. A most important point in its favor at this time is the fact that it increases the man-power of the shipyard by releasing for other work all mechanics usually employed in lining out and fitting a wood deck. Furthermore, the work of laying magnesite composition decking is let out to a contractor at a definite price per square foot, thus relieving the purchasing, accounting, stores, and traffic departments of a large burden which would ordinarily be theirs if lumber were to be bought, expedited over congested rails and stored for a considerable time. Lumber is difficult to obtain and is therefore constantly rising in price.

Materials

The materials of which magnesite composition decking is composed are available in large and increasing quantities in this country. They consist of calcined and ground magnesite mixed dry with certain fillers calculated to give the finished product hardness commensurate with elasticity; and this mixture is added to magnesium chloride solution in a mortar box and applied to the deck with a trowel, the deck having previously been covered with suitable contrivances to "key" the composition to it. The composition, when troweled, presents a smooth and level surface, unbroken by seams, pleasing to the eye and of remarkable strength and durability.

It is considered the best practice, as an insurance measure, to coat the deck first with a suitable bituminous solution in a heavy coat, although the writer has seen several deck plates bared of composition decking during repairs that showed no corrosion whatever.

Speed of Application

Composition sets up in about ten hours during the hot summer months, and in about 48 hours during mid-winter. It cannot freeze, hence there is no interruption of operations. One mechanic with helpers can apply from 250 to 500 square feet per working day, so it will be recognized that the most rapid construction will not be delayed because of its use. Rather will deliveries be hastened, because the trowelers may start as soon as the deck plates are complete in place, and this fact serves to increase the incentive to spur the riveting work. The joiners start to work immediately the decking is set up, and they fasten their sills to the material with ordinary wood screws, so that they keep behind the trowelers, spurring the latter in turn, to greater effort. It was figured that on an 8,000-ton passenger steamer, built on the Atlantic Coast a few years ago, magnesite composition decking delivered the ship from four to six weeks ahead of schedule. Think what this means to-day!

Best Magnesite Produced in California

The principal source of magnesite for use in floor or deck composition was in Eubea in Greece, prior to the present war, but during the past three years practically all the magnesite used for this purpose has come from California. It is mined, sorted, and burned, to free it of practically all of its carbonic acid, then ground and packed. The California product has always been known to be superior to any other in the world, but, because of the low cost of production, the Grecian material could be laid down in this country at a price far less than the cost of production of the California material, plus the relatively high freight rate. The California firms are now producing to capacity and a tremendous amount of money has been spent in the development of new mines and the purchase of machinery for calcining and grinding. The production of magnesite in this country, not only for flooring compositions, but for refractory and fluxing purposes as well, has proven to be a very important "war baby."

Practically all magnesium chloride, which is used in the wet mixture of magnesite composition, came from Germany until about four years ago. It was obtained as a by-product from the production of potash from carnallite, a native salt found in the salt beds at Stassfurt. After the potassium chloride had been extracted by crystallization, the residue was packed and shipped as magnesium chloride, and as a consequence it carried a number of impurities. Now there are firms in the United States producing better and purer magnesium chloride than ever came from Germany and furnishing it to the composition trade as well as other industries in the United States.

The resourcefulness of our manufacturers is to be commended for making possible the continuation of a business which is destined to play quite an important part in our shipping program.

Laying of Magnesite Composition Decking

Magnesite composition decking may be used merely as a sheathing, a suitable rubber tiling being glued to it, or it can be laid as a combination sheathing and surfacer. Mineral colors incorporated in the mixture give a very pleasing effect to the finished floor. Laid in one unbroken layer, it requires no calking or repairs and presents no harbor for vermin. Inasmuch as its principal ingredients are refractory, the finished floor is both fire proof and non-inflammable. It may be truthfully stated that no material of a hydraulic nature is watertight, strictly speaking, because of the voids caused by the evaporation of water. Magnesite composition, however, in tests has absorbed less than 2 percent of its own weight of water after being submerged for four weeks. This test was performed with a sample, only ½ inch thick, so it will be seen that the penetration is not very deep.

* Secretary Marine Decking and Supply Company, Philadelphia, Pa.

It can safely be considered as watertight. It is comparatively noiseless to the tread and is quite efficient as a thermal insulator, so that it is warm to the touch.

Composition flooring, as it is called in the building trades, had been in use on land for a number of years before it was thought of for ship decking. It is a widely discussed material among architects and most of them will agree that, properly applied, it is an ideal floor where beauty and utility are to be combined. The same statement holds true for marine work.

Type of Composition Decking Must Be Carefully Chosen

Dr. John Hamilton Patterson, in the September, 1914, issue of *The Shipbuilder,* lays particular stress on composition decking of the magnesite type. He discusses very fully all types of decking in his article, "Deck Sheathing Compositions," and referring to magnesite composition decking, he states: "There can be no doubt that some compositions as laid down are unsatisfactory or even dangerous, but given rigid adherence to certain conditions they are as safe as, or safer than, wood or other deck." Dr. Patterson's article was an exposé of some of the causes leading to the occasional failure of decks of this type abroad, where they have been in use for years.

Practically every large liner built in Europe has, since about 1904, been covered with magnesite composition decking, and since the demand was so great, there sprang into existence any number of contractors who took contracts at low prices, sophisticated their material, and "skinned" their jobs, with the result that the sheathing disintegrated, and often the deck corroded. Shipping interests began to look askance at any sort of composition decking. The quotation from Dr. Patterson's article speaks for itself, and, inasmuch as America will be the world's largest buyer of material for building ships, it is imperative that Dr. Patterson's words be heeded so that Europe's mistakes in choosing the kind of magnesite composition decking are not repeated.

Therefore, in choosing, the shipbuilder or owner must consider the reputation and experience of the firms bidding for the business, and the efficiency of the organizations bidding for the work should also be closely scrutinized. There is so much of care in the purchase, the manufacture and the testing of the raw materials, so much of experience necessary in their proper application, that it behooves those responsible to choose wisely before naming the kind of material to be used, because thousands of dollars may be lost, not only by the failure of the sheathing, but the corrosion of the plates beneath as well.

Beware of Irresponsible Contractors

There have been many firms who have started up as magnesite composition contractors with only enough capital to buy a few tons of raw materials and pay their mechanics for a few weeks. The principals in these firms have usually been men who have worked at laying these floors, and they seldom are equipped with the necessary knowledge of the chemistry of the material they apply. The use of rule of thumb methods, in a business which is extremely technical, and the fact that such a limited amount of capital is required to commence operations, have persuaded them to embark in business with subsequent disaster, not only to themselves, but to the trade at large. When a particular brand of magnesite composition fails in service, the critic does not particularize, but condemns "composition" generally, which is manifestly unfair to those firms with considerable invested capital, an organization of experts, and a reputation for good work.

A frequent cause for the failure of magnesite composition in service is a reduction in the percentage of magnesite used, or a decrease in the strength of the magnesium chloride. These two ingredients are the highest in price of all the materials entering into magnesite composition decking, and are therefore most likely to be reduced by unscrupulous contractors.

Therefore, it is urged that the shipowner and shipbuilder should make diligent inquiries as to the respective standing of all bidders, their experience in applying magnesite composition on ships in particular, as well as specifying a definite course of procedure as follows:

Specification

(1) Specify the application of a heavy coat of bituminous material which will adhere permanently to the steel deck and which will not become brittle.

(2) Maximum and minimum thicknesses (the latter over butt laps) to be specified and enforced to prevent unscrupulous contractors from "skinning" the job.

(3) Specify that a satisfactory method be employed of bonding the material to the steel deck. "Roughing up" the deck is not satisfactory.

(4) Specify that the material must be such that it may readily be tapped with woodworker's tools and yet not so porous as to retain more than a slight amount of moisture.

(5) State that consideration will be given only to those firms which have laid material satisfactorily on ships, satisfactory proof of this to be furnished.

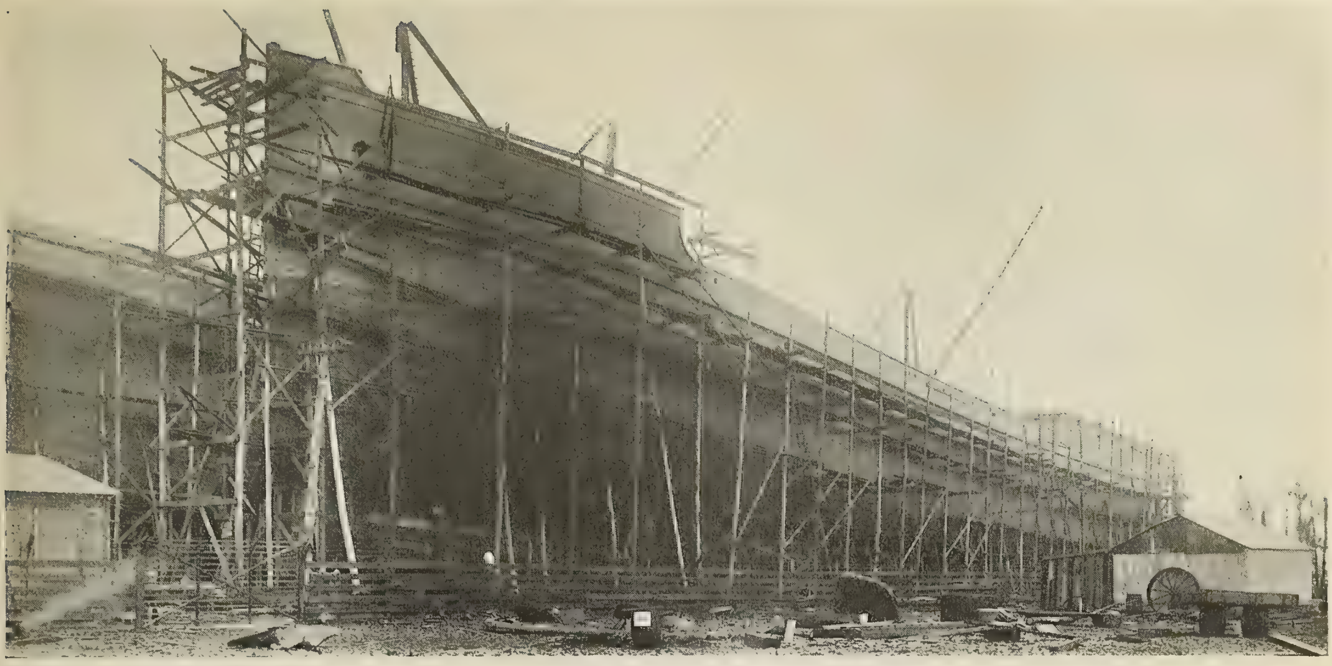
Unless the foregoing general rules are strictly adhered to, there will be some dissatisfaction expressed in this country, as well as in Europe, in the future, regarding magnesite composition as a ship decking. Those firms in the business who are in a position to comply with the specifications given will welcome investigation, because they are in the business to stay, and will, with the help of the shipping interests, do at least their bit in hastening deliveries. These firms know the merits of their products, are sure of their ground, and are confident that the ultimate judgment of the shipping world will verify the fact that magnesite composition stands pre-eminent as a decking for ships the world over.

Largest Wooden Vessel Launched

The *War Mystery,* the largest wooden steamship ever built, and of an entirely new type of construction, was successfully launched at an American port on February 27. If the confident prediction of the designers and builders is realized, this vessel will end the controversy as to the practicability of the wooden ship and the problems that have hampered its rapid production.

The *War Mystery* is the first of twin vessels contracted for by the Cunard Steamship Company and built by the National Shipbuilding Company of Texas. The second vessel, which is practically complete, and which was christened the *War Marvel,* was sent into the water two weeks after her sister ship. Lying on the ways in the National Company's yards are six other ships of the same type that are being rushed to completion under a Government contract which calls for a total of twelve ships from this company. The first of the Government ships will be launched about April 1, and the others will follow at intervals of a few days.

In design and construction, the *War Mystery* and her sister ships differ radically from the Ferris type of wooden ship adopted by the Emergency Fleet Corporation. One of the principal differences is that the *War Mystery* has



The *War Mystery* Under Construction in Texas by the National Shipbuilding Company

a deadweight carrying capacity of 4,700 tons, as compared to 3,500 tons of the Ferris model, yet the larger vessel requires less than 1,500,000 feet of material to construct, as compared to approximately 1,750,000 feet required for the Ferris ship. Another feature that is said greatly to facilitate rapid production of ships of the National Company's design is that they require no timbers of extraordinarily large size, so that the Southern lumber mills are able to supply easily and quickly any quantity of material desired. Southern lumbermen have insisted that if there has been any delay on their part in supplying material for the Ferris type ships, it has been due solely to the requirements for timbers so large and long that it was next to impossible to find them in the Southern pine forests.

The *War Mystery,* which is identical except in a few minor details with all the wooden vessels being constructed by the National Shipbuilding Company of Texas, has a length over all of 315 feet, and a length between perpendiculars of 300 feet; a molded depth of 28 feet 6 inches; molded beam, 48 feet; beam outside planking, 49 feet 7 inches; draft, 24 feet. She is built throughout of dense Southern yellow pine, with the exception of stem and stern posts and engine foundations, which are of oak. Among the unique features embodied in her construction are:

Frames of "built-up" timbers, scarfed and tied together with hardwood treenails, machine driven. Directly upon the outside of the frames and continuing uninterruptedly beneath the hull on top of the keel is nailed a double layer of diagonal strapping of material 1¼ inches thick and 9 inches wide. These diagonal courses are laid at right angles to each other and are designed to aid in giving the vessel extraordinary rigidity and strength, offering resistance to tension, compression and strain from every

View on the Deck of the *War Mystery*, the Largest Wooden Steamship Under Construction

angle. The outer planking proper varies in thickness from the garboards, where it is 8 inches, to 5¼ inches on the vessel's bottom, and 4¾ inches on the sides. The sheer strake is 7 inches in thickness. Inside the vessel is ceiled throughout with 7-inch planking.

The vessel has a comparatively light keel—9 inches. The bottom of the ship has a floor of solid timbers, laid three deep and totaling 36 inches in thickness. The keelson is a steel plate 5 feet wide, running the entire length of the vessel, and on which is mounted a fore-and-aft wood girder 18 inches deep. The bottom of the ship is further reinforced with additional keelsons of wood, 15 inches square, one at the turn of the bilge and the other midway between the bilge timber and the metal keelson. The heavy timbers in the vessel are fastened with screw bolts, instead of the clinch bolts frequently used.

The largest single sticks required in the construction of this vessel are the deck beams, extending from side to side. These are 15 by 15 inches, 48 feet in length.

Propelling Machinery

The vessel will be driven by 1,450-horsepower, triple-expansion, reciprocating engines, with Babcock & Wilcox watertube boilers. Another variation from the Ferris type ship will be the location of the machinery, which in the *War Mystery* will be well toward the stern of the ship, rather than amidships. This arrangement leaves the cargo hold "all together," and this, with three unusually large hatches, will make loading and discharging cargoes exceptionally easy.

The vessel is not intended to carry sail, and the masts will be derrick posts 45 feet in height, built to fold down upon the deck, so as to lessen the visibility of the ship and reduce the danger of being accurately located at a distance by enemy vessels.

The *War Mystery* and the sister vessels of her type have been given an A1 rating by Lloyd's.

The officers of the National Company say they can produce ships of the *War Mystery* type within thirty days after construction begins, and, since the company has ways for eight vessels, the future production will be at the rate of thirty-two ships annually.

Rapid Growth of the National Yard

The work already accomplished at the National yards is a remarkable example of "speeding up" to meet urgent war needs. On May 1, last year, the site of the shipyards was the boggy, reed-grown shore of a river. To-day it is fully equipped with everything needful in the way of machinery for modern shipbuilding, is already well on its way to the production of eight ships complete, and has a trained working organization of more than nine hundred men, exclusive of master mechanics and directing supervisors.

The owners and directors of the National Shipbuilding Company of Texas are for the most part men largely interested in oil, and when the installation of a shipyard at this port was first undertaken the purpose was to build steel oil tankers, an intention that was abandoned, temporarily at least, when this country entered the war with Germany. The principals in the organization are: A. A. Daugherty, structural contractor and engineer, formerly of California; P. J. Reilly, of Philadelphia, president of the National Oil Company; John F. Penrose, of Philadelphia, owner of oil properties in Mexico; G. Van Alstine, of California, secretary of the company, and W. A. Ebsen, of New York, ship designer and engineer. Concerning the vessels being built at the National yards, Mr. Ebsen, the company engineer, said:

"These ships, as we are equipping them, are not intended for speed, though they are designed along clean and graceful lines. They are, however, built for hard, practical use in the North Atlantic or any other sea, and we have not the slightest fear of their failing in any particular. We are giving each vessel built the most careful study, and are constantly adding minor improvements that tend to increase the stability and serviceability of our ships. I can scarcely believe that any practical designer or builder who inspects the *War Mystery,* our first production, lying there in the harbor can doubt that she is a staunch, practical and thoroughly seaworthy ship."

Thousands of residents of this port city and scores of shipbuilders, lumber manufacturers and others directly interested in wartime shipbuilding cheered while the *War Mystery* glided into the water on the day of her launching. The launching was an entire success, in spite of natural difficulties presented by a very limited expanse of deep water adjacent to the shipyards.

Cargo Steamship Santa Tecla Launched by New York Shipbuilding Corporation

Originally started as a stock hull by the New York Shipbuilding Corporation, Camden, N. J., the S. S. *Santa Tecla,* a cargo vessel of 3,800 tons deadweight carrying capacity, which was launched 85 percent complete on February 28, has been taken over by the United States Shipping Board Emergency Fleet Corporation. The keel was laid in September, 1917, and, considering the weather conditions of the past winter, the construction of the vessel has progressed very rapidly.

The vessel is a single screw steel freighter with machinery amidships. The length overall is 310 feet 5¾ inches; length between perpendiculars, 299 feet 10½ inches; beam, molded, 40 feet and depth molded 26 feet. On a draft of 21 feet, the vessel is designed to carry a total deadweight of 3,800 tons, and, in this trim, to make about 10 knots sea speed under ordinary conditions.

There are two decks with poop, bridge and forecastle and an inner bottom which runs throughout the length of the vessel. The inner bottom is divided into sixteen compartments for carrying fuel oil and water ballast. Steel deck houses are erected on the bridge deck with a wood pilot house and captain's quarters, on top of the bridge deckhouse. The officers and engineers are berthed on the bridge deck and the crew aft.

The cargo space is divided into three holds with four hatches, 24 feet by 14 feet, fitted with shifting beams 4 feet apart. The hatch covers are of wood in small portable sections. The total capacity of the cargo holds is 165,000 cubic feet. The forward end of the midship house is also available for cargo, worked through large door openings on each side of the forward bulkhead.

The fuel oil is carried in bunkers located abreast the boiler room and in the double bottom. The peaks are also riveted and stiffened for carrying oil but are not piped for this purpose. The capacity of the fuel oil bunkers, exclusive of the peaks, is 600 tons at 40 cubic feet per ton.

Drinking water tanks of 7,000 gallons' total capacity are provided and reserve feed tanks are under the machinery in the double bottom.

The vessel is schooner-rigged with two steel masts heeled on the main deck. Four steel booms are fitted to each mast, each capable of handling a 3-ton working load. Between the forecastle and bridge and poop, bulwarks have been dispensed with, and a double chain rail fitted instead.

Propulsion is by a vertical inverted direct-acting triple expansion surface condensing engine, arranged to work on three cranks, and to drive a right hand screw propeller. The cylinders are 19¾ inches, 31½ inches and 54¼ inches diameter, with a common stroke of 36 inches. Steam is supplied at 200 pounds working pressure by two single ended Scotch boilers, 13 feet mean diameter and 11 feet long between heads.

The engine bedplate is of cast iron, of strong box sections with six iron girders of box section, suitably recessed for the main bearing boxes, bolts and nuts. The main bearings are six in number, of the square bottom type to facilitate re-lining. The upper caps and boxes are of cast steel in one piece; the lower boxes of cast iron.

The cylinders are supported on three front and three back housings of cast iron box section, provided with suitable flanges for attachment of the cylinders and to the bedplate. The high pressure and intermediate pressure cylinders, each have one piston valve and the low pressure cylinder, one double ported slide valve—all worked by Stephenson link motion.

The main condenser, containing 2,100 square feet of cooling surface, is independent of the main engine. The pumps for fire, ballast, etc., are all independent and located in the engine room. The auxiliaries also include an electric plant consisting of two vertical marine generating sets of 7½-kilowatt capacity. A main switchboard and distribution panels are provided for controlling the lights in the living quarters, etc. Approximately one hundred 110-volt 25-watt Mazda lamps are fitted throughout the vessel.

Great Lakes Shipping

According to William Livingstone, president of the Lake Carrier's Association, the 1918 season on the Great Lakes will open propitiously. In his annual address to the association he said:

"The association will begin 1918 with an increase in membership so far as the number of vessels is concerned. No material losses through shipwreck were sustained in the past season, with the exception of the small freighter *Goudreau,* and the sales of vessels in memberships to the Atlantic coastwise service were small in comparison with the preceding twelve months. The requirements of the Government have so far been largely confined to the package freighters, and have removed only seven vessels of 15,893 gross tonnage from our membership.

"Our extensive building programme commenced before the war seemed a possibility, reached completion with the launching of the steamer *August Ziesing,* on October 30, and this new construction, together with some recovered property, has added to our membership twelve bulk freighters of 89,301 gross tonnage, of which seven are 600 feet and four 545 feet overall in length.

"Until the war will have come to an end there can be no hope for any further increases in our association's tonnage through new construction. Nevertheless, the present membership represents a total of 2,084,922 tons, an amount adequate for successfully handling almost any burden that the nation may impose upon us."

Reviewing the season of 1917, which, through weather conditions, was very unfavorable, Mr. Livingstone said:

"All available ships were ready early for opening navigation on April 15, and the outlook appeared optimistic, inasmuch as Lake Erie, from Detroit River to Conneaut, was clear of ice on March 20, while the Cleveland harbor opened on March 16, an advance of three weeks over the preceding year. On April 1 the river and channels up to Lake Huron were open and the steamers *Maruba* and *Emory L. Ford,* that had been caught at Port Huron at the close of navigation in 1916, proceeded down with their cargoes of grain. On April 12 the steamers *Wm. P. Snyder, Jr., Col. J. M. Schoonmaker* and *Shenango* made a dash from Buffalo harbor with the hope of getting through, as they did one year previously, but they were caught in the ice three miles up the lake and held until April 19.

"In the upper lakes and rivers the ice conditions were the worst of a decade. On March 30 there were 26½ inches of ice at the Sault, and 38 inches in Duluth harbor. There was found at the head of Lake Superior the unusual condition of 28 inches of hard, blue ice and heavy ice extended out from Two Harbors for twelve miles.

Sault Locks Opened Late

"Not a downward cargo passed through the locks at the Sault in April, but Lake Michigan and the Straits having kept free, it was possible to trade with Escanaba, with the result that twenty-four cargoes of ore got away in April, but only ten were delivered in the month, equally divided between South Chicago and Lake Erie ports. The steamer *Martin Mullen* reached Cleveland on April 27 with the first ore cargo, and on May 1 the *Hydrus* reached Buffalo ore-laden.

"It is notable that the first round trip from Buffalo to the head of the lakes, as made by the *T. H. Wickwire,* was not completed until May 8, while the first round trip to Duluth, as made by the *Harvester,* was not completed until May 10. Throughout May this tedious, expensive condition continued.

"In July the fleet brought down 10,241,633 tons of ore, the largest in history, and this was accomplished after the most serious unloading delays in the first ten days of the month that a modern fleet ever encountered.

Grain Trade Spectacular

"The grain trade of last spring and summer was spectacular in all its aspects and contributed one of the most interesting chapters to the eventual year's business. Although the stocks in the Northwest were considerably reduced in comparison with other years, a demand for tonnage made itself evident early in the new year.

"During the flush of grain's activity 149 steel bulk freighters participated in the movement. The late opening of navigation and the interference of ice set the fleet back about three weeks, it was conservatively estimated, and yet up to June 1 the Buffalo elevators unloaded 44,190,336 bushels and the loss stood at only 1,410,416 bushels from the exceptional rate of the year previous."

Remember, oil is lazy and very unobliging; it will never accommodate you by working to the center of a bearing, but will always work from the center out.

Many engineers forget, or never knew, that in a non-reversing engine only one side of the crank pin gets any wear. Think this statement over and you will find it true.

If the fillets of a crank pin are touched by the ends of the brasses when cold, when they warm up they will expand onto the fillets, lifting or tending to lift the brasses from the pin, thus resulting in cutting or heating, and you have trouble. See that there is a good clearance between fillets and brasses. A little too much is better than not quite enough.

Fig. 1.—Reinforced Concrete Pier Shed at Thirty-Fifth Street Pier, New York

Concrete in Marine Terminals

Retaining Walls, Breakwaters, Piers and Pier Sheds Being Built of Concrete—Permanence and Utility

BY H. COLIN CAMPBELL*

MORE marine terminals are needed to-day to take care of the enormous shipments of war materials and men, as well as for increasing export trade in every line. The present demand for terminals is not a temporary one, but will increase in the future rather than decrease. Boats are being built in large numbers and provision must be made for loading them rapidly. The use of concrete in this work in the past, its value now when terminals must be prepared in haste, and its possibilities for future construction are proper subjects for discussion in this journal.

Terminal facilities have always meant the development of a country, even as the lack has retarded progression. Venice was one of the first cities to take full advantage

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Fig. 2.—Interior of Pier Shed, Thirty-Fifth Street Pier, New York, Showing Reinforced Concrete Deck and Steel Roof

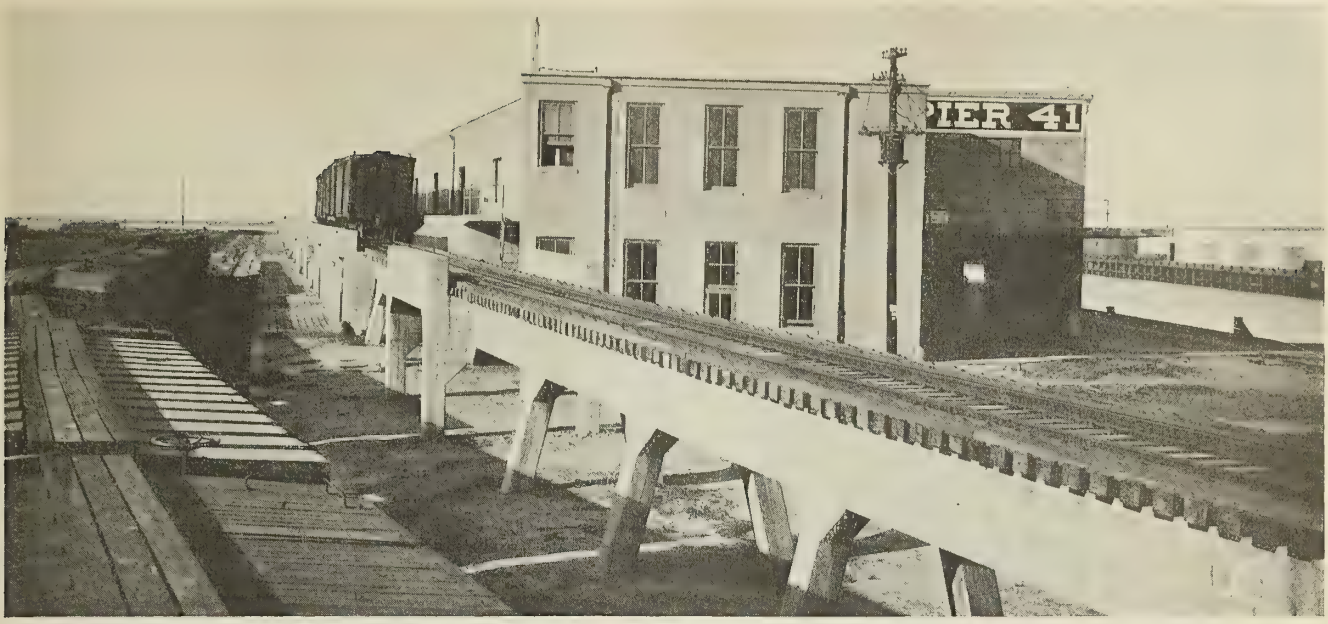

Fig. 3.—Pier No. 41, Galveston, Texas. A Reinforced Concrete Trestle Bridge Gives Permanent and Uninterrupted Track Service to This All Concrete Pier

of terminal facilities and its location made it ideal for unloading and distributing goods. For years the wealth of the world was carried by the Venetian ships. To-day, England owes much of her maritime prominence to the terminal facilities of the British Isles, and the United States must realize the importance of marine terminals to our industrial and national expansion. The broken shore line of our coast, particularly the Atlantic Coast, gives practically unlimited locations for terminals. The nature of the frontage, location of railways and lines of communication make construction difficult in some places, but, through the use of concrete, terminals have been and are being built, and concrete bridges, causeways, viaducts, and roads give access to them. Concrete sea walls, and breakwaters protect the harbors, and concrete lighthouses point the way to the safe channels.

Marine terminals are the logical result of a productive country, as well as of international commerce. To require or use imports, a country must be prepared to give

Fig. 4.—Concrete Pier Construction in San Francisco. Sub-Structure of Pre-Cast Concrete Pile

either raw material or manufactured goods in exchange. This implies facilities for loading and unloading boats and trains quickly and economically.

Terminal facilities include safety to boats while at the dock, and to the goods until they leave. This applies to shipments in as well as out. It implies safety from the tidal currents and sea dangers, as well as from fire, collision, etc. Goods must be kept dry, kept cool at times, yet at all times accessible. Safe passage to open water must be maintained. Some goods for some points must be held in storage until a boat is available, and therefore, goods must be packed to overcome the difficulties of shipping when port facilities are limited or practically non-existent.

The diversity of products furnished by the United States or shipped from its ports and the variety of goods received necessitate a considerable variety of terminal facilities. To some extent these materials are localized, while in others they form the miscellaneous cargo. Galveston and New Orleans are prominent cotton shipping points. Duluth, Buffalo, and Chicago handle grain; Ashland, Wis., Cleveland, and Ashtabula specialize in ore; Baltimore and Philadelphia in coal; Portland and Seattle in lumber; New York, Boston, and Philadelphia in manufactured goods. Each commodity requires special facilities for economical handling, and yet each of these ports handles large quantities of other materials.

A similar condition is found in the imports. Boats from South American ports bring mahogany logs roughly squared—perhaps three feet square, sixty feet long, and weighing perhaps ten or fifteen tons. San Francisco unloads tons of Chilean nitrate. New York receives boatloads of bananas, oranges and tropical fruits. Other ports receive similar shipments, and the goods must usually be transhipped to the point of final destination. As a rule the larger the port from which a boat comes, the more general its cargo, while with exports the smaller the port of destination the more varied the shipments. Each terminal port must therefore be prepared, for this means that ships must sail in ballast or light, or seek other ports for a return load. Highly specialized lines, such as tank steamers, ore and grain boats, may have difficulty in obtaining return cargoes, but in the main the rule will be found true. The development of fixed markets has led to the establishment of liners, while the lack of regular cargoes has added to the number of "tramp" steamers.

Ideal marine terminals should therefore be prepared for the convenience of passengers, raw materials produced in the tributary district, such as cotton, grain, provision, coal, lumber, and building materials, machinery and equipment, as well as manufactured articles.

Fig. 5.—All Concrete, Fireproof Pier of Delaware, Lackawanna Railroad, Hoboken, N. J.

Location of Marine Terminals

The location of marine terminals is based on a number of conditions, some of which vary greatly in the methods used to make them efficient.

The first requirement is sufficient depth of water for the vessels which will enter the port. Assuming the ocean highway has a sufficient depth, the immediate locality may be dredged to the required depth. At some places where the range of tide is great, small vessels may rest on the bottom or on shelves constructed alongside the dock. At times an enclosed harbor may have tide gates to be opened only at stated tide heights; or locks by which boats may leave or enter practically free from ocean currents.

The locality should be largely free from currents, floating ice, wind and waves. It should have easy and safe access from the sea at all hours, and sufficient area to accommodate the heaviest probable traffic. This includes warehouses, storage bins, unloading space, railroad tracks, etc., necessary for economical operation. There should be freedom from labor troubles, particularly a shortage of freight handlers.

The first requirement practically means building the terminals from the bottom of the harbor. Some terminals have been built on solid ground, and the depth of water obtained by dredging, while others have been built on land a little above the sea level, the solid ground for foundation being obtained by dredging and filling; and some in relatively deep water. A combination method is usually the result when building a terminal of any size. A firm foundation must be found to provide for the weight of the buildings and docks, to resist the horizontal forces, such as the impact of vessels, currents, floating ice, etc., and the outward pressure of the soil. The project must also be economically practical.

Depending on the nature of the material to be handled, the terminal itself must be equipped with railroad and team tracks, trucking space, cranes and derricks for unloading, facilities for loading and unloading large and small boats, and for transshipment via cars and lighters and vice versa.

Goods in transit must be protected from the weather.

Fig. 6.—Concrete Cylinder Pier Construction at San Francisco

Thus a port shipping grain requires elevators for such protection as well as rapid handling. Food products fruit and vegetables, require cold storage. Bulky machinery, lumber, and finished woodwork must often have storage space and be covered with tarpaulins, etc.

Newark Port Development

Frontage on navigable water is so valuable that dockage can seldom be confined to frontage only. Cargo ships being 500 or more feet in length, it is manifestly a saving of space to construct slips between the docks, thus greatly increasing the capacity of a given frontage. A typical method of meeting this problem may be seen in the layout of seven 1,200-foot piers for the Newark Port development. The frontage is about 4,000 feet on Newark Bay, including a 400-foot ship canal. Dockage along the seven piers provides 16,800 feet of space, while one side of the ship canal furnishes an additional 5,000 feet suitable for transference to and from cars or lighters. A concrete retaining wall six feet thick at the bottom and eleven feet high holds the filling material dreged from the bay and pumped by a suction dredge a distance, in some instances, of over a mile.

A similar use of concrete may be found in the Hunt's Point Terminal in New York. Here 3,600 feet of bulkhead served to reclaim over 200 acres of swamp land. A block of concrete approximately seven feet thick and ten feet high retains the filling.

Victoria, British Columbia, solved a similar problem quite differently. A breakwater 2,500 feet long was built with a concrete core faced with granite. Two piers having berthing places for boats 800 and 1,000 feet long are built out into the harbor, the depth of the water being up to 60 feet or more. A foundation of rubble was built up to 35 feet below low water and reinforced cribs 35 by 80 feet and 39 feet high were built on shore, floated to place and sunk to the bottom. The crib was then filled with loose rubble. On top of the crib a concrete retaining wall is built to hold the fill. Somewhat similar cribs have been used at Copenhagen, Denmark, and in the new work of the Welland Canal.

New York Piers

Not all ports have unlimited water front area, however. The flow of rivers must not be unduly restricted, and the Government wisely limits the projection of piers, bulkheads, etc. The piers of New York, for instance, including the parts of New Jersey contiguous, have in many places reached the limit and recourse must now be had to extending the piers shoreward. This is expensive in many places, and particularly so in upper Manhattan. In the municipal pier in the North River at the foot of West 46th Street, over 200 feet of rock excavation was needed to provide 1,000-foot piers. The pier walls are concrete retaining walls varying from a minimum of 10.2 feet thickness, about 20 feet high to 23 feet thick, and 56 feet high. Forty-four feet of water is provided at the piers.

In the Chelsea District of Manhattan, piers were extended shoreward about 500 feet on land, formerly (about

1840) filled in and built up with factories, warehouses, etc. The inshore fronts of the pier sheds are concrete on expanded metal supported on steel girts. The possibility of settlement on the made land led to a construction in which any section might be jacked up when necessary.

When a great range in tides must be considered, it is found advisable to build enclosed docks large enough to take any vessel coming to that port, and provided with gates to prevent danger to the shipping, etc. Such a project is being built at Chemulpo, Korea, and consists of a dock 700 by 1,500 feet inside, provided with storage sheds and railroad connections, and inclosed basin, and a tidal lock connecting the dock with the outer harbor. Mass concrete is used liberally, the sides of the dock being on the average about 18 feet thick, 64 feet high, while the bottom is from 13 to 15 feet thick, reinforced with steel rails.

Lake Washington Canal Locks

A somewhat similar project is being carried out at Seattle, Washington, where a ship canal eight miles long is being built to connect Lake Washington with Puget Sound. This will give Seattle a fresh-water harbor of about 25,000 acres, with a shore-line about 100 miles long. A lock near the lower end of the canal will pass vessels 825 feet long, 80 feet in width, and drawing 36 feet; 200,000 yards of concrete will be used in the lock alone.

To provide additional anchorage and docking space, England has under consideration an almost parallel case at Loch Lomond in Scotland. A concrete dam and locks will permit sea-going vessels to use the lake for anchorage, while the shore line may be built up with the necessary repair shops, docks, and terminal facilities.

Breakwaters Built of Concrete

Concrete in the form of massive blocks is being increasingly used for building breakwaters and other protective works. The Panama Canal Breakwaters at Limon Bay, the Atlantic or northerly entrance to the Canal, are protected by concrete blocks from 4 foot 6 inches to 7 foot cubes. About 20,000 of these blocks were used for this purpose.

Considering the city of Galveston as a whole as a terminal, the harbor may be described as a lagoon between an island and the mainland. All the terminal facilities are on this lagoon, the city proper is on an island. The entire side of the island fronting on the Gulf of Mexico, exposed to the full sweep of the sea, is protected by a concrete seawall 16 feet high, 16 feet thick at the bottom and 5 feet wide on the top. This concrete wall saved the city and terminals from destruction in the great storm of August 16-17, 1915, although considerable damage was done to the causeway from the mainland to the island. The concrete warehouses, grain elevators, and terminal structures were comparatively unharmed.

Concrete Piles

Concrete piles for the support of docks and wharves at San Francisco illustrates a typical use of this material. During the last twenty years a large number of piles have been used for this purpose. The concrete is generally reinforced, and is either in the form of cylinders or piles. In the former the concrete is deposited in wood or steel forms and hardens in place; while the latter are cast in a convenient locality, seasoned from 30 to 60 days, and driven by pile drivers, steam hammers, or water jet. The latest practice in building cylinder piers is to use a steel form about three feet in diameter, which is withdrawn after the concrete has sufficiently hardened. The concrete piles, in general, are preferred in San Francisco, as any defects are more readily apparent.

Piles used in this work have been made as long as 106 feet and as large as 20 inches square, and have given complete satisfaction. A minimum depth of water of 33 feet is provided, while in some places the ends of the piers are in water 50 to 70 feet deep. The piles are cast in suitable yards and allowed to harden about 30 days before being driven.

Docks on New York Barge Canal

Terminal docks of the Barge Canal at Albany, New York, consist of docks formerly in use, to which was added a reinforced concrete sheet-pile bulkhead, having Raymond concrete piles about 25 feet long capped with large blocks of concrete driven some 20 feet back of the bulkhead and anchored to it with steel ties.

At Troy a concrete retaining wall extends to the bottom of the canal, while at the Western terminus at Buffalo, a portion of the wall is timber cribbing filled with rubble and topped with 8½ feet of continuous concrete wall. The lower 3 feet is of concrete blocks 6 by 10 by 3 feet, the top 5 feet being cast in place.

London Marine Terminals of Reinforced Concrete

The Port of London Authority, established in 1909, has already effected many and great improvements in the new port of London, providing facilities for handling both passengers and freight. Buildings for many purposes have been erected or are in process of erection, and three of the latest buildings are for cold storage, refrigerating station and transit shed. These are all practically reinforced concrete, resting on 30-foot concrete piles, 12 to 16 inches square. The cold storage building is 307 feet long by 100 feet wide, six stories high, the framework of reinforced columns and beams having brick panel wall filling for external and cross walls. Reinforced concrete beams 40 inches by 14 inches run longitudinally through the building connecting the bases of the columns and supporting secondary beams 18 inches by 9 inches which carry the floor slab.

The columns on the ground floor are 24 inches by 24 inches, and reduce in size regularly to the fourth floor where they are 18 inches by 15 inches. The main beams are generally 30 inches by 18 inches with 16-inch by 10-inch secondary beams.

The transit and cold storage shed is 1,000 feet long by 123 feet wide, also designed with reinforced concrete pile foundations, beams, columns, and floors. The floor is designed to carry 300 pounds to the square foot, and a feature of the shed is the cartway area 100 feet wide. Reinforced concrete girders of 50 feet span carry the second floor load as well as crane loads of 33 tons.

Ocean Steamship Terminals at Halifax

Concrete was largely used in the construction of the ocean steamship terminals at Halifax, N. S. Provision was made, on a 6,000 foot frontage, for six piers 340 feet wide and 1,250 feet long, separated by basins 350 feet wide and 45 feet deep. Berthing space is provided for 27 large steamers. The sides of the piers are built up of hollow concrete blocks 22 by 31 feet, 4 feet high.

We have mentioned only a few of the features of some of the most recently built terminals. The part which concrete has taken in each one would require a volume in itself. For the future we can only see a greater use of concrete than in the past, for its merits are well known, its qualities have been proven, and its economy is apparent.

Marine Terminal Engineering

Lecture Delivered Before the Electrical Engineering Institute Section, Sheffield Scientific School, Yale University

BY H. MCL. HARDING*

TERMINAL engineering includes that branch of engineering pertaining to port development, except that which is strictly harbor engineering and which now is for the most part under the jurisdiction of the engineers of the War Department of the United States.

Increase of Domestic and Foreign Commerce

The following figures indicate the great increase in the domestic and foreign commerce of the United States since 1914.

The congestion which has resulted from this great increase and which is so disastrous to the business of the United States, is due to the inefficiency of terminals. These terminals being inadequate have clogged the railway transportation system of the country, and while this congestion has seriously affected all classes of freight, that pertaining to fuel is the most acute. Before 1914, there was congestion from any comparatively small increase of traffic at most of the railway terminals, and the late James J. Hill, the president of the Great Northern Railway, long before he died, predicted the present condition, and stated that to bring up the terminals to an equality with the rest of the railway equipment (meaning cars and tracks) would require a terminal investment of more than eight billions of dollars.

Before the present war, there was about 4,000,000 tons of shipping in the United States. Within the next three years there will be more than 16,000,000 tons.

In 1900, the value of the home trade of the country was $11,700,000,000 (£2,400,000,000), for 1914 it was $29,900,000,000 (£6,140,000,000), and for the year 1917, $64,100,000,000 (£13,120,000,000).

In 1900, the foreign trade was $2,307,095,827 (£473,000,000), in 1914 it was $3,902,000,000 (£800,000,000), and in 1917, $9,050,000,000 (£1,850,000,000).

From the above figures of the increase in domestic and foreign trade, it is evident that the present number of marine terminals will be greatly increased within a few years, and that the railway terminals must be equipped with the latest electrical freight handling machinery, whereby the freight handling capacity of a given area of ground can be doubled or trebled. To correctly equip these terminals calls for the highest class of electrical engineering.

Number of Marine and Railway Terminals

There are to-day over 3,500 marine and river terminals in the United States, and in addition, according to Mr. Fairfax Harrison, president of the Southern Railroad, between 250,000 and 300,000 railway terminals or freight stations. The port of New York is counted as one terminal. Many marine terminals are combined marine and railway terminals.

Electrical Adaptation

At many of these terminals there will be the adaptation of electricity and especially as pertaining to the transferring and handling of cargoes and freight.

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The number of marine and river terminals will be greatly increased, possibly doubled, within the next two years, on account of the coming merchant marine of the United States and the greater utilization of river and canal transportation by power boats and barges.

Few railway or marine and river terminals are now properly equipped.

This new adaptation of electricity to terminals is a comparatively new industry and opens up a new important field for invention, design and initiative, and affords probably more opportunity for quicker personal advancement than does any other branch of engineering.

Terminal Investments by Cities

The investment in marine terminals, especially by municipalities, often runs into millions, but it is a paying investment and adds nothing to the tax rate, often reducing it. The following list of cities is an evidence as to the terminal activities, whereby cities and states are constructing terminals for future ownership, control and operation.

Cities Constructing Terminals

Boston, Mass.	Elizabeth, N. J.
New Bedford, Mass.	Perth Amboy, N. J.
Providence, R. I.	Camden, N. J.
New York, N. Y.	Jersey City, N. J.
Trenton, N. J.	Newark, N. J.
Philadelphia, Pa.	Chester, Pa.
Baltimore, Md.	Jacksonville, Fla.
Buffalo, N. Y.	Wilmington, Del.
Superior, Wis.	Cleveland, Ohio.
Chicago, Ill.	Montgomery, Ala.
Mobile, Ala.	Orange, Tex.
Port Arthur, Tex.	New Orleans, La.
Beaumont, Tex.	Pensacola, Fla.
San Diego, Cal.	Los Angeles, Cal.
Oakland, Cal.	San Francisco, Cal.
Richmond, Cal.	Portland, Oregon.
Seattle, Wash.	Tacoma, Wash.
Astoria, Oregon.	St. Louis, Mo.
Minneapolis, Minn.	St. Paul, Minn.

The above list is receiving additions nearly every week.

Terminal Principles

For those electrical engineers who were called upon to design and construct terminals, as well as city authorities who are considering the development of their waterfronts, the following method of procedure may be of service:

In designing all new terminals, the harbor line having been determined, there should be a comprehensive layout which should indicate all future units and be a plan which can be followed during many years in the future, when extensions are made.

To be successful, it must be designed from the electrical freight handling standpoint, and not from the use of the two-wheeled hand truck.

Terminal Elements

The elements of a marine terminal consist of piers, slips, quays, railroad tracks and various railway yards,

sheds, warehouses, dray areas, open storage spaces and often public markets, cold-storage buildings, coal pockets and manufacturing lofts. There are also administration buildings, warehouses and open areas for special commodities.

Freight Movements

The following are the principal freight movements which require electrical appliances:

(a) Between the ship and the open pier, the open quay and the shed or warehouse.

(b) Between the ship and other ships or vessels (transshipments).

(c) Between the ship and cars (outbound freight).

(d) Between the shed and the warehouse.

(e) Between the ship and dray and open areas.

(f) Between the cars and terminal buildings.

(g) Between any of the buildings or areas within the terminal lines.

Terminal Units

Although the marine terminal consists of these many elements, yet for convenience in financing, in construction, and in operation a terminal is now divided into unit sections, each section being a complete workable, income-producing terminal unit, similar to the other units, which are to be added as traffic increases but without change in the first unit.

At different ports, with quay construction, the chief variations in units would consist in the size of the elements and in the length of the lineal berthing feet apportioned to a unit. The length of this unit frontage is determined by the maximum length of the freighter which will use the unit.

Size of Units

Such a unit would therefore contain, for an inland river terminal, for freighters of 500 feet in length, of a berthing frontage of 500 feet of quay wall, a shed of a length of 400 feet, a warehouse the same length as the shed, but wider, the quay, the shed and the warehouse served by railway tracks and mechanical appliances.

An inland river terminal unit for barges of not over 350 feet in length would consist of berthing frontage 350 feet long, a shed 300 feet in length, and a warehouse also 300 feet in length, equally well served by railways and machinery.

For the larger ocean ports, each unit should be 600 feet in length, but there should be two units adjoining in one straight line so as to berth two ships, each of 600 feet, or an ocean liner 1,000 feet or more in length. The shed should here be 500 feet long and the warehouse 500 feet.

The port works, for convenience, may be separated into two divisions, the substructures and the superstructures; the port facilities, into railway tracks, railway connections, motor trucks, electrical appliances, universal or overhead cranes, carriers for miscellaneous cargoes and special electrical appliances.

Substructure in Terminal Construction

This substructure, to avoid interruption in commerce, should be permanent, that is, safe from fire, rat proof and decay-resisting.

Fresh Water Quay Terminals

As many of the new ports are inland, where the water is fresh and free from teredo and other destructive agencies, there are given a few detailed views of an adaptable type of construction.

In this type, all wooden piles or platforms are always below the mean low water elevation, and above this elevation is a permanent concrete wall and behind the wall and above the relieving platform is a filling of earth, sand or cinder, securely paved with concrete and asphalt.

Relieving Platform

As is well known, it has been, in the past, difficult, except at an enormous expense, to construct a permanent quay wall, which would not be pushed out of alinement by the earth pressure. At a depth of 40 feet this pressure is often 20,000 pounds or more per square foot.

The natural slope of the earth is not disturbed if at about 1 on 2 slope. This natural slope is blanketed by riprap at 1 on 1 slope, to prevent washing or erosion caused by the movements of the ships, seepage, or heavy rains.

The piling being always below low water, is driven into this unchanging natural slope, and above and supported by these piles are cross caps and the grillage or relieving platform, all of great strength, sustaining the concrete wall and the paved filling.

There is, therefore, visible, an indestructible, smooth, solid concrete gravity wall, some seven or more feet wide at the base and three or four feet wide at the top. (These dimensions vary according to the height of the wall.) The piles below the water are always saturated and will not burn or decay.

The installation cost is not much more than that of an inflammable wharf of creosoted piles and wooden flooring.

Teredo-Infested Waters

In case the water is salt, infested with the usual teredo, then the piles and the relieving platform are of concrete.

In the case of projecting piers, as into a harbor or large turning basin, the construction is the same, but is equivalent to two quay walls, one on each side of the pier, back to back, with a solid or pile center between.

The pile center is used where the volume of the flow of the river must not be obstructed.

Shed Capacity

It is a good rule to plan the shed for such a capacity that it will be possible to distribute all the goods taken from one ship berthed opposite to it. This is the rule at Hamburg, Germany.

When goods are handled by hand, the average height of tiering or piling averages about 5 feet. It is, therefore, evident that there would be required a very large floor area to distribute and place a cargo of 6,000 tons, according to the marks and cross marks, especially if a miscellaneous cargo.

Tiering either 15 feet or 20 feet is necessary to avoid too great an expense for land areas, to shorten the frequent movement in the shed, to reduce the initial investment in the shed, to prevent the installation of tiering and other machinery to be installed.

Terminal Buildings

At every quay terminal there should be two principal classes of buildings, having entirely different functions; one is the shed and the other the warehouse. These are of different design and construction.

Transit Shed.—The transit or transfer shed should be a steel structure, comparatively narrow, but high studded, twenty-five to thirty feet under the trusses, one story and well lighted in every part. Its length is about equal to four-fifths of the length of the longest freighter, which will berth opposite to it, and its storage capacity equal to two cargoes of such a freighter. It is for the handling of cargoes and a place of intense activity, for the tem-

porary holding of goods for not more than 48 to 72 hours. It is not a storage warehouse.

Warehouse.—The warehouse is of four to six stories in height, somewhat wider than the shed, of concrete construction, a building for as long storage as may be desired. Goods therein stored are to be kept safely.

The warehouse being for long storage, often of months' duration, since the goods may not be moved during this time, should not usurp the position or function of the transfer shed, but should be placed to the rear of the shed and parallel to it for the shortest and the easiest movements between the two buildings.

Railroad Connections

There should be two or three railway tracks between the shed and the quay wall and other tracks to the rear of the shed.

Electrical Appliances

These appliances are divided into two classes, the first external for transferring, that is, for discharging and loading the vessel, and the second internal for handling, that is, assorting, distributing and tiering.

For transferring miscellaneous cargoes, there are used the full or half arch traveling gantry jib cranes of from two to five tons capacity at 200 feet per minute hoisting speed, with an outreach of 50 feet at 50 feet above the quay wall, with a lift of 80 feet. The same crane can be used for both two tons and five tons—two tons at an outreach of 50 feet, and five tons at an outreach of 20 feet.

All three or four movements are performed by separate electric motors at a minimum of cost for transferring.

By means of these cranes, outbound freight can be swung from the car to the vessel.

Inbound freight, however, must be distributed and tiered, and therefore, in general, the movement by the crane is to or within the doors of the shed from the ship. This distribution between the movements of the outbound and inbound freight is important.

To supplement the gantry crane service, and to prevent the usual congestion, either outside or within the shed, there are electrical traveling bridges similar to shop cranes.

Other Electrical Freight Handling Types

There are many other types of hoisting and conveying appliances installed at marine terminals, but these, as a rule, are designed for special commodities and not for universal application. It is possible only to enumerate the most important. Portable electric dock winches; stationary electric dock winches; floating steam hoists or electrical hoists; floating grain elevators; whip hoists; traveling unloaders, 5 to 10 tons capacity; elevated stationary hoisting winches; pillar cranes; locomotive cranes; stationary bridge cranes; lifting towers and belt conveyors; derrick booms and grab buckets; coal dumps on tipples; barrel conveyors and elevators; gravity chutes and conveyors; bag and box chutes; baggage escalators; motor trucks; cargo chutes; blind-hatch hoists; stationary cranes, hammer type, of great capacity.

Almost without exception these are electrically operated.

Terminal Designing

It is evident from the above, that the terminal works, including substructure and superstructure, must be correctly planned and the electrical appliances and other facilities properly adapted to the work, with sheds and warehouses rightly proportioned to the size of the ships, and the railway tracks co-ordinated for direct transference between water and rail and the ship and the shed.

The example herein given, as to the cost of a terminal quay, will indicate the advantages attained by following terminal principles. Similar advantages can be secured in other designs and layouts, as in shed construction and methods of operation. The data from the following mentioned ports are official.

Certain portions of some of these ports were improved and other portions were allowed to remain without change. There were also the reports covering the whole waterfront of these ports for a number of years before any improvement had been made, which figures are used for comparison.

The figures represent actual conditions and the tonnage of the cargoes transferred during a number of years.

	Tonnage per linear yard per year Before Improvement	After Improvement
Havre, France	385 tons	1,430 tons
Marseilles, France	665 tons	1,694 tons
Rouen, France	483 tons	1,121 tons

At the present day, still further advances have been made in design and improved mechanisms, which will increase the tonnage of the improved sections still further over those of the unimproved sections.

From the above data and similar reports, the superiority derived from the improved designs and mechanisms is in the ratio of about 450 tons per linear foot frontage per year for the improved sections to 150 tons per linear foot for the unimproved sections.

To transfer and handle 150,000 tons per annum would require a linear frontage of 1,000 feet at 150 tons per linear foot. At 450 tons per foot, there would be required only one-third the length of frontage or quay, or 333⅓ linear feet. This 333⅓ linear feet, all things being equal, would require an initial investment of one-third of what would be required for 1,000 feet, to handle an equal tonnage of 150,000 tons in a year. There would be better facilities and equipments on the 333⅓ linear feet, so that the investment for the 333⅓ would average about one-half the terminal quay cost for the 1,000 linear feet.

If there be taken into consideration the purchase price of the land, the dredging from the river channel to the quay and other conditions, it will be seen that the cost for the 1,000 feet will be much more than twice the investment for the 333⅓ feet.

Conclusions

First: For all ports, those harbor works, terminal facilities, operating methods, and electrical appliances should be adopted which have proved most efficient in respect to time and economy of cargo transference and handling.

Second: That all new terminals for inland and ocean navigation should be so designed, planned, and proportioned in respect to the piers, quays, sheds, warehouses, and railway tracks, as to secure easy, quick, and economical interco-ordination between all these terminal elements and with the water carriers.

Third: That not only should the world's best be adopted and then adapted by terminal engineers to the operating conditions of each location, but terminal engineers should continually study to achieve something better.

Fourth: That the securing of the greatest speed possible in all marine freight terminal movements is of all terminal features that which is most essential.

Fifth: Any port which hopes to secure its share of domestic and foreign commerce must build permanent and fireproof quays and piers and such as will not be liable to an embargo on account of epidemic.

Sixth: No port and its hinterland, with its factories, mines and farms, can even hope to hold its present position

if a large seaport, or to attain to its rightful heritage, unless it provides the terminal facilities, as sheds for temporary holding, and electrical freight moving machinery to attract the shippers, consignees and shipowners, and have available warehouses for long storage.

Seventh: Its chances of holding even a rear position in the race for supremacy are small indeed, unless it has complete electrical co-ordination between rail and shore, according to the best designs and plans.

Eighth: A terminal quay of modern design and correctly equipped for rapidly transferring and handling a given tonnage of freight within a given time will require an investment of about one-half that usually required and can be constructed in one-half the usual time.

Ninth: No port to-day can afford to ignore terminal engineering principles if it is to secure and retain its share of foreign commerce. A merchant marine without terminals is like a railroad without freight stations.

How Modern Welding Processes Save Time of Ships in Dry Dock for Repairs

Some Recent Achievements by the Thermit Process in the Quick Welding of Heavy Sections

NOW that the call is for ships, ships, and yet more ships, it has been necessary for marine engineers to turn their attention to the quick repair of vessels as being of almost equal importance to the rapid construction of new tonnage. It is self-evident that if a vessel can be repaired and taken out of dry dock in two or three days by utilizing one of the modern welding processes it would be a crime to keep the vessel in dry dock for any longer period and make the repair by the old-fashioned methods, which are now practically obsolete, and which are still adhered to by only a few engineers of the fossil variety. The German ships would still be out of commission if the Government had not utilized modern methods.

The thermit welding process is one of those which has come very rapidly to the front within the last few years, as it is the only process which has consistently and successfully welded the heavy sections of a vessel which occasionally break, such as the stern frame, the rudder frame, the rudder stock, the tail shaft or crank shaft. All these sections are much too heavy to be successfully repaired by either oxy-acetylene or electric welding, the reason being that in the case of both these processes the metal is fused in only drop by drop, and it has been found impossible to prevent the formation of innumerable internal shrinkage strains, which invariably cause trouble later on. The only reason thermit was not used in repairing the German ships was because the Germans did not break any sections sufficiently large at the fracture to require a thermit weld.

The principal reason for the success of the thermit process in the welding of heavy sections is due to the fact that the metal to make the weld is produced in bulk at the exceptionally high temperature of 5,000 degrees F. The weld is achieved by pouring this superheated liquid steel around and between the parts to be welded together. It then melts those parts up and thoroughly amalgamates with them to produce a single homogeneous section when cool.

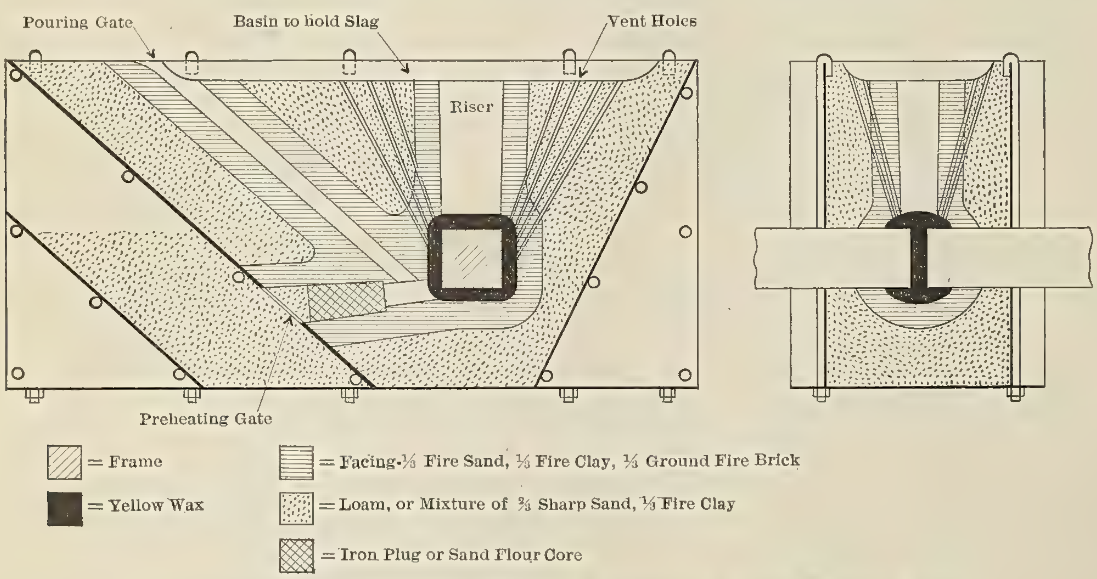


Fig. 1.—Construction of Molds and Materials Required for Making Thermit Welds

For the benefit of those who may not be familiar with the details of this process, it might be well to state that thermit is a mixture of aluminum and iron oxide. This mixture can be ignited at a temperature of about 3,000 degrees F. upon which a chemical reaction takes place. The aluminum burns, and in so doing takes away the oxygen from the iron oxide, thus setting the iron free. This iron is precipitated as a mild, low carbon steel. The aluminum oxide formed by the reaction floats on top of this steel in the form of a slag, and the temperature of both

Fig. 2.—Stern Shoe on S. S. *Henry Stienbrenner* of Kinsman Transit Company, Welded July, 1917

slag and steel has been calculated at about 5,000 degrees F. Thermit gives half its weight in steel, but the quantity of steel, as well as its quality, is increased and improved by the adding of certain metals and additions to the thermit powder. In practice, about 15 percent mild steel punchings is mixed with the thermit, together with 5/8 percent nickel shot and 1 percent pure manganese. With these additions, thermit gives about 65 percent of its weight in a very high quality of steel.

In practice, a thermit weld is made by first separating the parts to be welded together from one to two inches, depending on their size. In the case of a stern frame of a steamship this space is cut out, utilizing the oxy-acetylene cutting torch for the purpose. A pattern of yellow wax is then shaped around these sections of the exact form of the collar or reinforcement, which is to be cast around them out of thermit steel. A sand mold is then formed around the wax pattern, using a special refractory molding material to stand the high temperature of the thermit steel. Wooden patterns are, of course, used for the pouring gate and riser, as well as for a small, preheating opening on one side. The general cross-sectional view of a thermit mold is shown in Fig. 1.

With the mold completed, the flame of a gasoline (petrol) compressed air torch is directed into the preheating opening, and this serves to melt out the wax, leaving the mold ready for pouring the thermit steel. The heating is continued, however, for a considerable period of time after the wax is melted out, in order thoroughly to dry out the mold and bring the parts to be welded to a red heat.

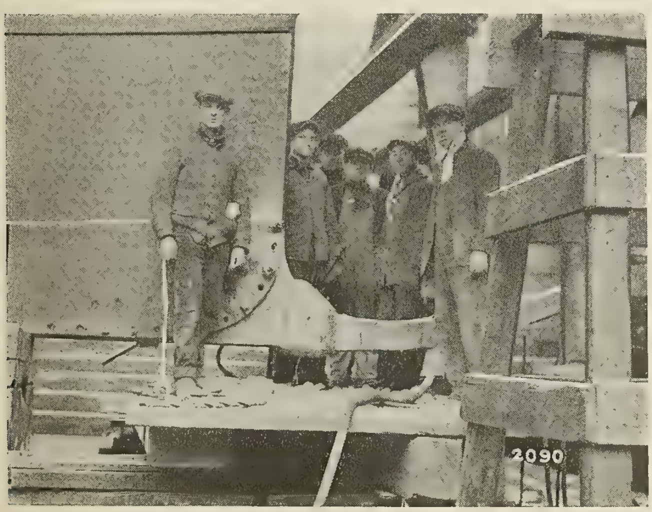


Fig. 3.—S. S. *Chas. O. Jenkins* of Jenkins Steamship Company. Section 14 by 18 Inches, Welded November 10, 1917. 700 Pounds Thermit Used. Time Used in Making Repair, 37 Hours, 10 Hours Preheating.

At this time the thermit charge is ignited in a crucible suspended over the pouring gate, and when the reaction is completed, which takes from 30 to 40 seconds, the crucible is tapped, allowing the thermit steel to flow into the mold, thus completing the weld. The mold is usually left in place over night, in order to allow the weld to cool slowly, after which it can be dismantled and the excess metal in the pouring gate, preheating gate, riser, etc., removed by means of oxy-acetylene.

Welds on steamers can usually be completed inside of 48 hours by this process, one day being required for ramming up the mold, preheating and pouring, and another day for cooling and dismantling. It is seldom that more than three days is required.

What this means to steamship companies can readily be appreciated when it is remembered that in previous years it has almost always been necessary to remove a broken stern frame from a vessel and either install a new one or else

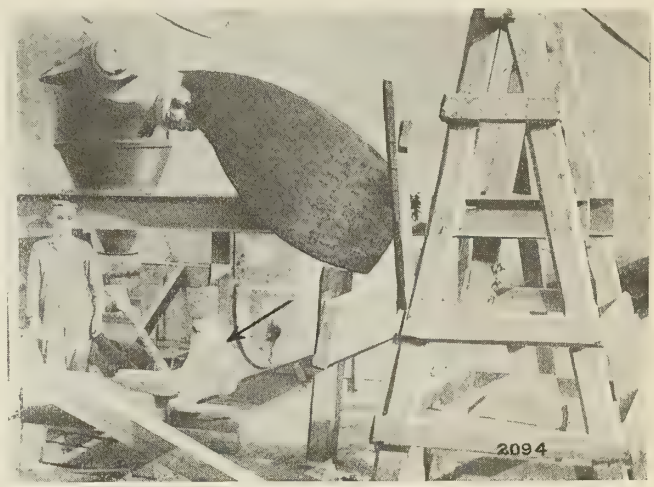


Fig. 4.—S. S. *Sierra* of Inter-Ocean Steamship Company. Section of Stern Shoe, 11 5/8 by 16 Inches, Welded September, 1917

repair the old one in a blacksmith shop and replace it in the vessel. A repair of this nature could never be completed inside of several weeks' time.

Thermit process has been utilized for many repairs on the Atlantic Coast, as well as on the Great Lakes and at Pacific ports. The accompanying illustrations show a number of the repairs which have been completed most recently.

The non-compressibility of water, coupled with the thickness of some men's heads, has helped the repair shops to several millions of dollars of work. We cannot change the nature of water, but we can do something with the men's heads.

A book will tell you how to open or close a throttle, but that operation is not all there is to starting and stopping an engine. You can get information from books, but never skill.

Every engine has its cylinder cover insulated, of course, but how many engines have you seen where the lower end of the cylinder is half as well guarded, if at all, as the cylinder cover?

The Preservation of Wood in Connection with the Building of Wharves and Docks

Advantages of the Creosoting Process—Treatment of Timbers for Dock Construction—Increased Cost Offset by Longer Life

BY HERMANN VON SCHRENK*

THE preservation of wood has been used for a great many years in connection with the construction of wharves and docks in various parts of the world. Its extensive use first came about in England in the early part of the nineteenth century, particularly on the part of the British Navy. The increasing scarcity of good timbers for dock and ship construction led to investigations as to methods of increasing the length of life of timbers for marine work. The extensive use of artificially preserved wood did not come into general use, however, until the middle of the last century, and may be said to have begun with the issuance of a patent in 1838 to John Bethel, who was the first one to use creosote oil extensively in the artificial preservation of timber.

Bethel's early work soon showed what remarkable results could be obtained from well preserved wood, and gave rise to the construction of numerous plants in England. In the United States the first timber-preserving plant was erected in 1860, although the first plant for the treatment of marine timbers was probably the one erected by the Louisville and Nashville Railroad in 1875 at West Pascagoula, Miss. This was shortly followed by a plant at Long Island City, N. Y., by Eppinger & Russell Company, in 1878; the New Orleans and Northeastern plant in 1879 at Slidell, La.; the Norfolk Creosoting Company's plant at Norfolk, Va., in 1896, etc.

Reasons for Creosoting Timber

In the United States the scarcity of timber had little to do with the impetus given to the creosoting of timber. The chief cause for its rapid development, particularly for marine work, was doubtless due to the high cost of replacing defective timbers after only a few years of service.

The short life obtainable from untreated timbers is due to two causes: (1) Decay, and (2) the attack by marine borers. Two forms of timber should be distinguished in any discussion of this subject—namely, piling and other timbers in direct contact with the water and timbers above the water line. Both piling and other timbers are subject to decay, due to various wood-destroying fungi. The extent and rate of destruction will depend largely upon the class of timber used. Round piling, with its ring of undisturbed sapwood, is particularly subject to decay, because the conditions under which it is used are very favorable for the growth of the wood-destroying forms. Hewn heart piling, which was frequently used in the early days, has a very much longer natural life, particularly the highly resinous yellow pine piling used along the Atlantic and Gulf Coasts. At best, untreated round piling will give only a very short length of life, and, as stated above, the replacing charges are very high.

The destruction of piling due to marine borers is very much more serious than the destruction by decay. The various marine organisms, including what are commonly known as ship worms, namely, the teredo (*Xylotrya*) and the crustacea (*Limnoria, Chelura* and *Sphaeroma*), have been the subject of much critical study during the past ten years, and their methods of attack and the manner in which they destroy wood are fairly well understood at the present time. They work most rapidly in warm waters, notably at points south of Norfolk, along the Atlantic Coast and on the shores of the Gulf of Mexico, and they are particularly active in the warm waters of the North Pacific. Dock timbers, meaning by this timbers used for the superstructure, will be destroyed by fungus decay, the rate depending largely upon the method of construction. Where timbers are enclosed so that high humidity prevails decay will be comparatively rapid, particularly if any amount of sapwood is present. Notable instances of this sort occurred within recent years in New York harbor, where the docks were entirely enclosed by means of thick oak planking placed all around the wharf to below water line for the purpose of fire protection. Numerous masses of fungi developed on the underside of this wharf, but were fortunately discovered before any serious damage was done.

Advantages of Using Chemically Preserved Wood

The great advantage of using chemically preserved wood is that all of the qualities of the timber are retained, and in addition thereto both the attacks from marine organisms and the destruction due to fungus decay can be largely prevented.

While a good many processes have been tried for the preservation of wood, there is practically one process which has stood the test of time when applied to piling and timbers for dock construction, and that is the creosoting process usually known as the full cell or Bethel creosoting process. The creosoting of dock timbers is carried out at a creosoting plant. Of these, there are now a large number on the Atlantic, Gulf and Pacific Coasts, and in England a similar number is situated within easy reach of salt water.

Creosoting Plant

A creosoting plant usually consists of a seasoning and storage yard and the creosoting plant itself. The piling and timbers are brought into the storage yard shortly after being cut in the forest. They are carefully piled so as to permit of rapid air seasoning. The creosoting plant itself is composed of one or more retorts or treating cylinders approximately 6 to 7 feet in diameter and 100 to 150 feet in length, provided with steam coils and tracks. In addition, there are a series of pressure, vacuum and air pumps, storage reservoirs for the preservative, measuring gages and dials to control every step of the operation.

In the Bethel process the air-dried timbers are pushed into the treating cylinder on small cars, and after the closing of the door a vacuum is produced. Where for reason of speed it is not possible thoroughly to air season the timbers and where it is necessary to treat green timbers, they are first subjected to a steam treatment. After the creation of a vacuum the creosote oil, at a temperature of 150 to 200 degrees F., is run into the cylinder until it is

* Von Schrenk and Kammerer, St. Louis, Mo.

completely filled and is then forced into the piling or timber until the best practicable impregnation is secured. The sapwood in all cases should be thoroughly penetrated. The oil left in the timber will depend somewhat upon where same is to be used. In northern waters, where the activities of the marine organisms are slight, 12 to 15 pounds are usually considered sufficient. In the warm waters of the tropics and along the Pacific Coast as high as 24 pounds are injected. Wherever possible the creosoted piling should be seasoned about three months before driving.

Timbers Should Be Bored and Framed Before Treatment

It is of the utmost importance that, if not impracticable, all timbers be bored and framed before actual treatment, so as to avoid injuring the creosoted layer during actual construction of the wharf. Many failures of so-called creosoted timbers have doubtless been due to failure to observe this precaution. Where it is necessary to expose untreated wood, for instance, after sawing off the tops of piles, after driving, the exposed surfaces should be given preferably two coats of heavy heated creosote oil. In the same manner creosoted oil should be injected into bolt holes or other injuries which are unavoidable. Where timbers are not exposed to temperatures exceeding 180 to 200 degrees F. the strength of the treated timber has been found to be practically the same as the untreated timber. In other words, creosoted piling and creosoted timbers can be used with exactly the same stress figures as for untreated timbers of the same character.

Different species of wood can be used. In the past the principal species used have been as follows: Southern pine along the Atlantic and Gulf Coasts and tropical countries tributary thereto; Baltic pine in England and other European countries; and Douglas fir, along the Pacific Coast.

Advantages of Creosoting Process

One great advantage of the creosoting process is that grades of timber can be used which otherwise could not possibly be employed in an untreated condition. A high percentage of sapwood is a desirable factor in timbers to be used creosoted, while they would be practically valueless in an untreated condition. Such pieces usually have a lower first cost than all-heart pieces. The usual grades for timbers are square edge and sound, except where excessive strength is necessary, in which case the grade dense pine (see standards, American Society for Testing Materials) should be used.

Creosoted timber docks will cost more than untreated docks, but in view of the very much longer life they are cheaper in the long run. A study recently made in connection with dock construction by the city of Chicago is of interest in this connection. Two docks were built, one a concrete dock along the collateral channel of the Sanitary District at the Marshall Boulevard municipal plant; the other a creosoted timber dock at Slip "A" of the Twenty-second street pumping station. In the creosoted dock all piles, capping, wales, stringers, sheet piling, battens and back logs were creosoted with 12 pounds of creosote oil per cubic foot. The cost of these docks, including excavation, but not including dredging, was: Concrete dock, $56.10 (11/13/9) per lineal foot; creosoted timber dock, $28.72 (5/19/18) per lineal foot. Quoting from Technical Letter No. 7 of the National Lumber Manufacturers' Association:

"For the purpose of mooring boats and loading and unloading, the docks are equally efficient; that is, from a strictly utilitarian point of view, either dock will serve the purpose.

"From the esthetic viewpoint, or for the purpose of carrying out some general architectural plan, the more expensive concrete dock might be favored.

"Assuming a conservative life of thirty years for the creosoted timber dock, a half century of service could be reasonably expected at the cost of the concrete dock. Therefore, from a purely economic viewpoint, if the cost of these two docks is indicative of what might be expected in this locality, the concrete dock must be classed as a luxury when compared with the creosoted timber dock. Moreover, the creosoted timber dock is more easily altered, is less likely to injure boats, and has a greater salvage value if developments require its removal."

In the foregoing quotation a life of thirty years is taken for the creosoted timber dock. This is an extremely conservative figure, in view of the experience of the past 75 or 100 years with the creosoted dock construction. Fig. 1

Fig. 1.—Section of Baltic Pine Creosoted Timber After 50 Years' Service in a Dock

shows a section of Baltic pine timber from one of the wharves of the British Navy Department on the River Nene, removed at the time of the reconstruction of the wharf. This dock had been in service 54 years at the time the writer made an inspection of this wharf, and practically all the timbers were in as sound condition as when first placed. Instances of this sort might be multiplied from all parts of the world. While there have been failures, these have doubtless been due to poor workmanship or improper construction. Thoroughly creosoted timbers have never been known to decay, and while the life of creosoted piling is probably not as long as that of timbers above water, particularly in tropical waters, 30 to 40 years' length of life may safely be assumed where a sufficient quantity of oil is injected and where the work is efficiently done. Contrast with this the service of untreated piling in Southern waters not to exceed twelve months.

Fire Risk

A word should be added as to the fire risk. Wooden wharves have burned in many instances in the past, and no discussion of wooden construction of wharves is complete without including this important subject. Creosoted timber and creosoted piles have a lower fire hazard than similar untreated timbers, irrespective of the species of wood of which they are constructed, particularly after they are four or five months old. Where proper conditions obtain they will undoubtedly burn, and when once thoroughly ignited a creosoted wharf will make a fierce fire. Prevention of fires in creosoted wharves, however, is an easy matter, provided proper attention is given to

design. Fires may occur either from the top of the wharves or from floating inflammable matter. By constructing tight docks much of the fire risk from above may be avoided, and the same is true when it comes to preventing ignition from below.

One of the chief causes of ignition of untreated wooden docks has doubtless been due to the formation of rotten holes and pockets containing tinder-like material which is easily set glowing by small sparks. Such pockets never form in creosoted timber, but the wood must start burning by direct ignition. In view of the fact that the kindling temperature for creosoted timber is very much higher than for untreated wood, it will readily be seen that the creosoted dock is a lower risk than the untreated dock.

Another phase obtained as a result of practical experience is that, while in many cases creosoted piling may take fire, these fires go out more rapidly of their own accord than is the case in the untreated material. Striking instances of this sort have happened during the past ten years, many of which came under the writer's personal notice. It is safest, however, to take all precaution by proper designing, so as to protect creosoted construction as much as possible.

The application of fire-resistive paint has done much to lessen the fire hazard. The chief conclusion to be drawn is that with proper designing a creosoted wooden dock may safely be considered a low fire-hazard structure.

In addition to the construction with piling and timbers which have been mentioned, a large number of docks have recently been constructed with creosoted yellow pine paving blocks similar to the familiar type of street construction. The blocks present a smooth, hard wearing surface, facilitate trucking, and when laid on a proper foundation will give a floor unequaled in service to any hitherto used.

Large Motor Passenger Vessel

BY A. R. JACKSON

FIG. 1 shows an interesting type of motor-propelled excursion vessel, built at Crescent Park, R. I., for summer service on Narragansett and Mount Hope Bays. This vessel was built by Mr. Charles Loof at his recreation park, near Providence, and was launched into a shallow lagoon connecting with Narragansett Bay.

The hull is constructed of wood, with oak frames and hard pine planking. It is V-bottom with scow ends and has no sheer. The main deck overhangs the hull, the overhang being supported on wooden knees.

The deck plan shows parallel sides with semi-circular ends, the bow and stern being alike. The hull is thoroughly fastened and is braced by diagonal rods running fore and aft on each side.

The principal dimensions are as follows:

Length over all	150 feet
Length on waterline	122 feet
Beam of hull	30 feet
Beam over guards	40 feet
Depth	13 feet
Gross tonnage	557
Passenger capacity	1,200

A large dance hall runs nearly two-thirds of the length of the hull, under the main deck. The engine room is aft of the dance hall, and a refreshment room forward. There is a large cabin on the main deck, with glass sides and comfortable seats.

The upper deck has a pilot house forward, and boats, rafts and other life-saving equipment in accordance with the requirements of the United States Steamboat Inspection Service.

Propulsion is by two 6-cylinder, 4-cycle Standard gasoline (petrol) engines, driving twin screws. The combined horsepower of the engines is 600, and the estimated speed 14 statute miles per hour. The fuel consumption at full speed is 75 gallons per hour.

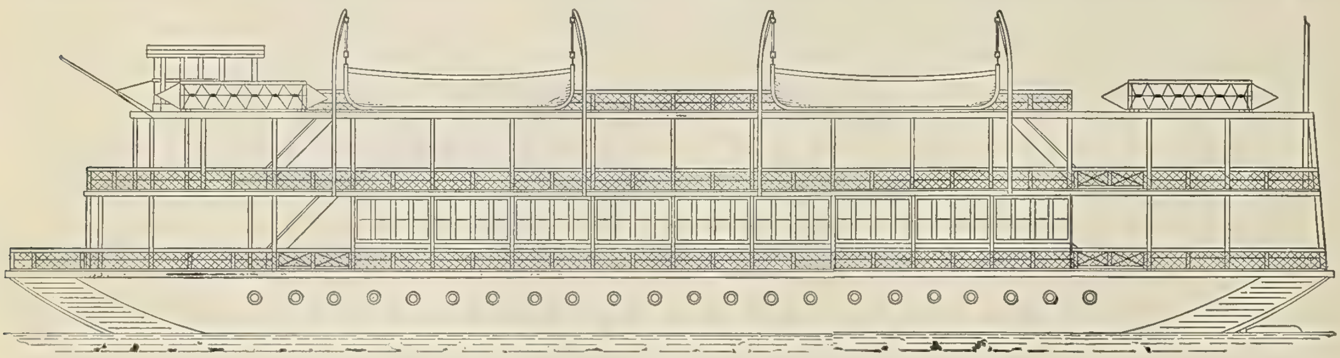


Fig. 1.—150-Foot Motor Excursion Vessel for Service on Narragansett Bay

The engine room is thoroughly fireproofed and ventilated. It contains, besides the main engines, 3 gasolene (petrol) tanks of 400 gallons capacity each, and a three-cylinder gasoline (petrol) engine direct connected to a dynamo for lighting the ship. A large fire and bilge pump is gear driven from this unit, with a disconnecting clutch.

An inclining test conducted by the Steamboat Inspection Service showed that this vessel has ample stability. It is well built and well equipped for the service for which it is designed.

A pair of scissors is on the market, one blade of which is corrugated. For cutting out gaskets and other material they will prove to be a very great time-saver. In heavy material they will cut far better than the usual shears.

Most engineers would have a fit if cast iron nuts were furnished for the valve chest and cylinder covers, yet one end of their studs is always in a cast iron nut. But on that account there are no fits, showing that it makes a mental difference which end of the stud you are thinking about.

A Swedish engineer had a neat way of making a loose stud hold. With a hack saw he cut two slots at right angles across the steam end of the stud the full length of the threaded part, and, after countersinking the end, he dropped a steel ball into the tapped hole of the stud, and screwed the split stud down onto it, which, of course, expanded the end.

Rapid Construction of Large New Shipyard on Pacific Coast Near San Francisco

Plant of Pacific Coast Shipbuilding Company, Covering 247 Acres, Begun January 6—First Ships Now Under Construction

A NOTEWORTHY feat has been performed in the speedy construction of the yard of the Pacific Coast Shipbuilding Company on Suisun Bay, about thirty-five miles northeast of San Francisco. Although the yard, embracing 247 acres, is regarded as the largest in area on the Pacific Coast and one of the largest in the country, and although the first construction work was done January 6, a building schedule has been followed calling for the first actual work on ships in March.

Company Includes Famous Shipbuilders

It is in this company that Henry T. Scott and John T. Scott return to the shipbuilding industry. Henry T. Scott was president of the Union Iron Works, in San Francisco, for about twenty years and for four years he was president of the Moore and Scott Iron Works—now the Moore Iron Works—one of the largest shipyards on the Pacific Coast. John T. Scott was connected with the Union Iron Works for twenty-five years, for the last fourteen of which he was its general superintendent. For eleven years he was vice-president and general manager of the Moore & Scott Company. He is vice-president of the Pacific Coast Shipbuilding Company, of which R. N. Burgess is president.

To Build Ten 9,500-Ton Steamships

The first job of the new company will be the construction of ten 9,500-ton deadweight steamers under government contract. While the $1,500,000 (£307,000) plant will not be completed till May, the work was taken up with a view to having enough equipment in place by March to permit a start being made on the ten vessels, which are to be delivered in twenty-two months.

It is expected that ultimately between 3,000 and 4,000 ship workers will be employed. The plans for the construction of the plant called for the maximum employment of 500 men in building work.

Six Weeks' Progress

The speed with which the building work was advanced by the contractor, the Lindgren Company of San Francisco, is indicated by the fact that in less than six weeks from the first day's work one launching way was 90 percent complete, another 65 percent, a third was ready for the concrete and dredging for the fourth had been finished. Seven launching ways in all have been planned for the yard, four being picked for immediate construction.

Within the same period of less than six weeks the plate shop, 400 feet long and eighty wide, of two stories—400,000 feet of lumber were required for this building alone—was almost complete, with foundations for tools being installed, the date of completion being set at March 1 or earlier. The foundations of other big buildings were in and the superstructures were going up. Sixty-five percent of the grading had been finished, and of the spur track system, more than two miles long, the main line was done, one branch was 80 percent laid, and the other was ready for the ties. Thirty percent of the 700-foot fitting our wharf had been piled and capped. Machinery for the plant was arriving and turbines and boilers for the 9,500-ton steamers had been arranged for. Ninety cars of materials were received and unloaded in this period of less than six weeks.

Location Advantageous

The shipyard is situated on the easternmost branch of the chain of bays beginning with San Francisco Bay. It is near the delta of California's two great rivers, the San Joaquin and the Sacramento, a circumstance of benefit as the fresh river water obviates teredos and barnacles, assuring long life for submerged timbers. The site has a 2,800-foot water frontage, with a 27 foot depth at high tide and ample room for launching large vessels. The property is traversed by three railroad main lines—those of the Southern Pacific, the Atchison, Topeka & Santa Fe and the Oakland, Antioch & Eastern. The power lines of the Pacific Gas and Electric and the Great Western Power companies parallel the railroads, and near by are the pipe lines of the Standard, the Associated and the Shell Oil companies, tapping California's big petroleum fields.

In addition to the 247 acres of the plant site, the company has at hand nearly 2,000 acres of land for supplementary purposes.

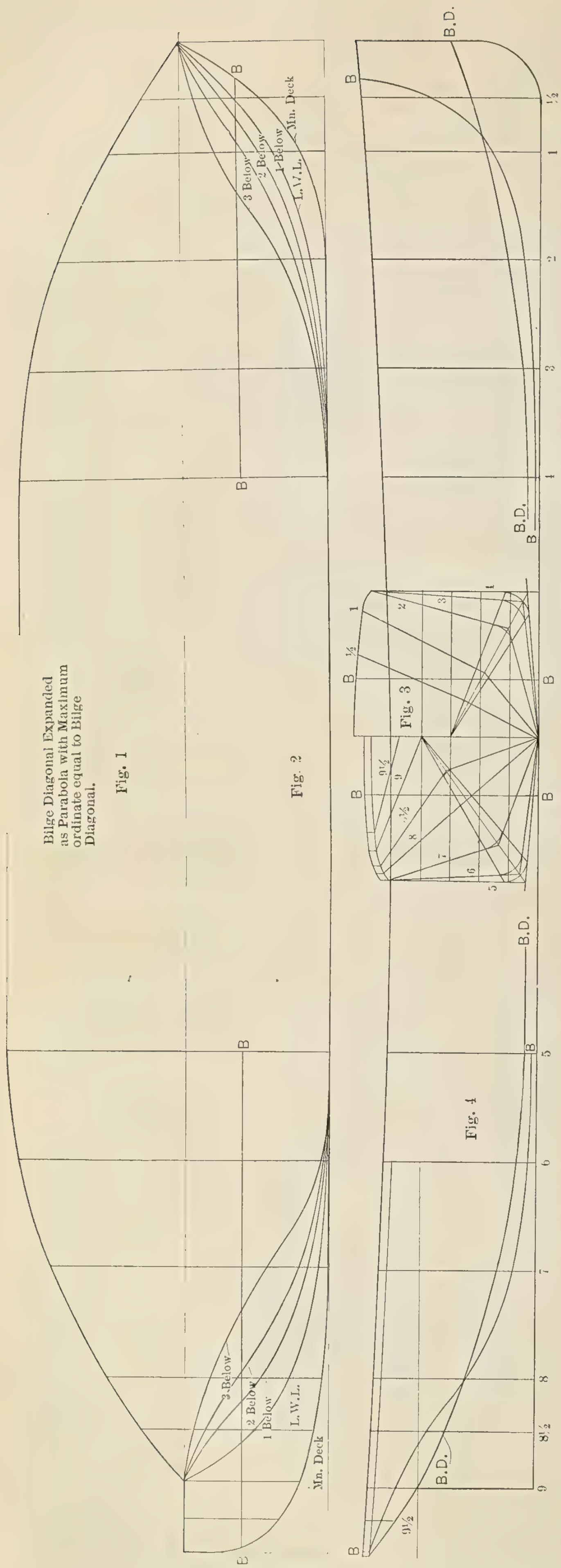
The buildings and ways were designed by Frederick H. Meyer, the architect of many notable works in and about San Francisco. The launching ways are 53 feet wide, with 95 feet between them, and the fitting out wharf is 50 feet wide.

Shops and Equipment

The buildings include a machine shop 120 feet by 400; the power house, 50 by 100; a two-story warehouse, 50 by 150; the planing mill, 50 by 80; an office building, 52 by 110; a hospital, large lockers near the machine shop and the plate shop; a blacksmith shop 50 by 100 and a building of equal size for the tin shop, carpenter shop, electrical shop and acetylene plant. The several tanks include one of 50,000 gallons, with the bay for source, for the sprinkler system.

Aside from the transportation and similar facilities at hand, the site was naturally well adapted to shipbuilding purposes, having physical and climatic characteristics conducive to the formation and continuance of a healthy industrial community. Within a few years several such communities have sprung up along the shores of Suisun Bay, such as Pittsburg, where the annual payroll is more than $2,000,000 (£410,000). Furthermore, the possession of an ample area for all purposes is regarded as another assurance of success, the success of the Newport News shipbuilding plant, with ample land holdings, being one precedent on this point. All the buildings of the Pacific Coast Shipbuilding Company's yard have been designed with the possibility of enlargement in view.

A main bearing cap in medium and small engines is not a binder, but forms part of a hole in which the shaft revolves.



Bilge Diagonal Expanded as Parabola with Maximum ordinate equal to Bilge Diagonal.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Straight Lined and Fabricated Ships

BY JOHN A. MC ALEER

THE word "fabricated" has been used and misused so much lately that, though one of its meanings is quite well known and probably remains unchanged, some of its other uses might be profitably defined and limited. While this may be a matter that will interest the etymologist more than the naval architect or shipbuilder, I believe that it may be broadly stated that a fabricated ship is one that has been built after the manner of bridges or steel buildings—i. e., that the steel work has been gotten out, fabricated, in one place and the vessel erected and put together in another.

The efficiency of this system has been so demonstrated time out of time that it was only natural to expect that valiant efforts would be made to apply it to shipbuilding in such times as the present. Many that proposed attacking the problem in this way did not thoroughly understand the difficulties in the way of a ship form. To fabricate flat or rectangular work that could all be laid out properly and accurately was one thing, but to attempt it in a gradually changing and somewhat indeterminate ship form was found to be quite another.

Fabrication of Dead Flat Sections Not New

There, of course, was found no difficulty in the so-called dead flat section. Nor was it all new to fabricate this. The Great Lakes yards have for years been practically using this principle in the building of their bulk freighters. The real difficulties were met in attempting to fabricate the ends. The reasons for this were in many cases quite obvious. The work was not flat, neither was it rectangular. The frames had to be heated and during the cooling certain errors crept in. During the later work, to remedy this the personal equation played a large part. Moreover, the transverse curvature of the shell plating varied from frame to frame and many of them had twist as well. The net result has been that the practical shipbuilder has been compelled to confine fabrication to the middle body, and, as has been noted, this is no new departure.

The principle of fabrication is admittedly a good one, but when applied to the ends of a ship the difficulty was purely and simply objective.

Fabrication of Ends of Ship

The next question is naturally this: if fabrication is a sound and economical principle, is there any way that it can be applied to the ends of a ship? The answer to this question is the incentive to this article. If the difficulties in the way of fabrication are mainly objective, then why not alter the ends and make them amenable to the system? The underlying reason for the application of fabrication to the dead flat is that this portion is nearly all straight-lined, and, consequently, this character must be impressed on the ends. If this can be done with no great alteration of the well-known ship form, and, at the same time, producing good, fair and easy lines, the difficulties can be considered solved. This is, therefore, the proposal of this article. Moreover, no claim to originality concerning a straight-lined ship is made. This type has had too many forerunners in the shape of the "Down East" dories and file bottom sharpies to have any such rash claims made, but in approaching the design of such vessels from a mathematical standpoint this article, it is believed, opens up a new field.

Figs. 1, 2, 3 and 4 show respectively the expanded bilge

diagonal, the half breadth, the sheer draft and the sections of such a proposed ship. To design one, the procedure would be as follows:

First assume a set of sheer heights and a set of deck half breadths. These could be taken from the dimensions of some vessel already built, or, in the case of the half breadths, the deck ends could be taken from the ordinates of an ellipse. As the deck outline will have some effect on the shape of the waterlines, it might be considered advisable to make the load waterline the governing upper curve and let the deck outline be formed from the continuation of the frame lines through these waterline ordinates. In forming the load waterline any of the mathematical methods of drawing such curves can be utilized, but it must be some curve with an equation so that the ordinates at all points can be computed.

Limiting Outlines of Cross Section

The next step is to lay off the limiting outlines of the cross section, as shown in Fig. 3, with the different waterlines, the dead rise line and the bilge diagonals. It would be well to terminate the after bilge diagonal at the intersection of the maximum draft line with the stern post. In the forward section good results have been obtained with the diagonal terminating at the three-fourths draft. However, these are points that could be specially determined from tank trials.

The next point to determine is the length of the ends or, what amounts to the same thing, the length and location of the dead flat section. This having been determined, an assumed expansion of the bilge diagonal must be made, its maximum abscissa being equal to the length of this end and its maximum ordinate to the computed breadth of the bilge diagonal as shown in the sectional drawing, Fig. 5. In expanding this diagonal, the further assumption must be made that its outline is some curve capable of mathematical delineation. Eye curves are not used. It must be some curve with an equation so that its ordinates at all frame points can be computed. In the design shown in the cuts, a parabola has been used, but perhaps even better results might be obtained with trochoids, cycloids or flat ellipses. However, to obtain a mathematical ship, it is quite necessary that the assumed expansion of the bilge diagonal be some mathematical curve. It now remains to be shown how every frame and angular direction in this ship can be computed. In doing this for a ship with curved lines, we first draw in the lines as though the ship were to have square bilges.

Frame Outline Divided Into Three Triangles

In Fig. 5, let the shaded portion represent a frame outline in the run. The outline is first divided into three triangles, as shown by the different shadings. In the lower triangle, $G\ B\ A$, we have $A\ B$ equal to the given draft, $G\ B$ the ordinate of the given parabola, used as the expansion of the bilge diagonal, and the constant and given angle γ. We therefore have two sides and the included angle and the triangle is therefore solvable.

The triangle $C\ F\ B$ is a right triangle and is also solvable, as $C\ B$ is known from the sheer heights and $C\ F$ from the half breadths. We solve this triangle to get the angle α and the side $B\ F$.

Turning to the middle triangle, we know the sides $B\ F$ and $B\ G$ and the angle β, which is equal to 180 degrees minus the sum of angles α and γ. This triangle can therefore also be solved.

All the line lengths and directions in this frame or any other can be computed in this way. The bevel ordinates can also be computed, the lower ones x-y being taken

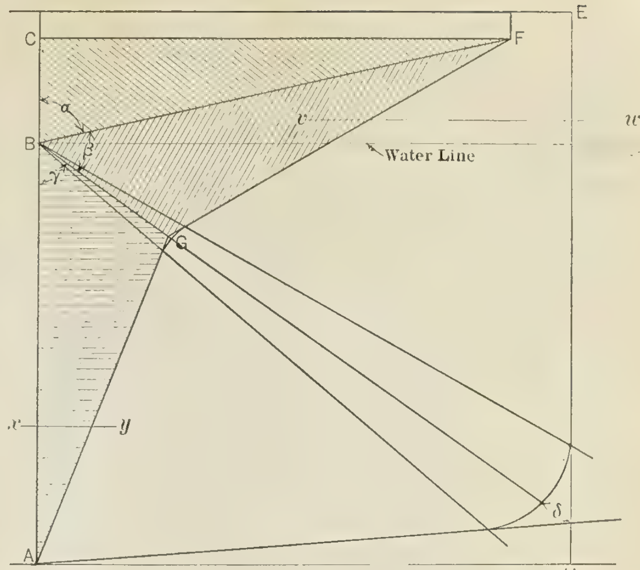


Fig. 5

from the midship line, while the upper ones, v-w, will be taken from $E\ H$. Of course the bevels can be more expeditiously taken from the lines after they have been drawn on the floor.

After the frame lines have been laid down on the floor, the knuckle is rounded in this manner. The bilge radius

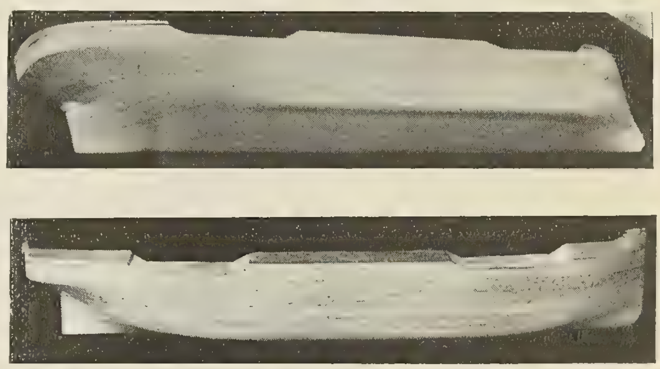


Fig. 6.—Model of the Straight-Lined Hull

for the dead flat section having been determined and drawn in on the floor (it is suggested that this be made as small as possible, not over 18 or 24 inches for large ships), two limiting diagonals are run in, cutting the frame line and the floor at the tangent points of this bilge curve. Where these limiting diagonals cut the frame and floor lines will mark the end of the straight-lined character of these members. The third point on the curved portion of the frame will come on the bilge diagonal proper and its intercept from the sharp knuckle point of its frame will be found by averaging along the number of frames the distance between the bilge curve and the square knuckle in the dead flat. In other words, if the distance δ in Fig. 5 is 20 inches, and it takes 20 frames before we reach a frame that is straight-lined from keel to deck, we will then decrease this value of δ 1 inch per frame. A mold would then be made for the curved portion of each frame.

The frames in such a vessel could all be bent cold in a beam bender, or perhaps locally heated, the bender being first set to the curve of the mold. And it is believed that these frames could also be beveled cold.

In practice, this mathematical computation would be not only tedious but quite unnecessary. The lines would, in

fact, be laid down on the loft floor, and the only necessary computation would be the ordinate of the bilge diagonal, breadths and heights having been, of course, assumed. And if a mathematical curve is assumed for this, a fair ship is assured from the body lines alone.

The body plan having been laid down on the loft floor and all the different lengths and angles computed, to get the shell expansion, the procedure could be as follows. Bearing in mind that all the frames and floors are straight lines, as far as the limiting diagonals, we can easily and cheaply make an exact replica of the ends of the vessel from wood joists and pine sheathing. On this, all the plates can be drawn full size with all the plate landings, butts, etc., and an exact mold, of sheet iron perhaps, can be made for every individual plate giving all the details. Furthermore, a line can be drawn on each plate mold, showing the direction in which each plate must be put through the rollers, when such a process shall be necessary. In this connection it is to be noted that as all the frames are straight-lined, there can be no variation in the transverse curvature, which eliminates one of the toughest problems in plating a vessel's ends. For convenience, so that these end molds would not be too bulky, each end might be made in two parts, one part above the bilge turn and the other below. Then each would appear somewhat like the banked curves of a race track.

The above is only given as a suggestion. It should be quite possible with careful work to lay out all the plating excepting the boss plates, down to the limiting diagonals, on any ordinary flat floor.

Expansion of Bilge Diagonal a Parabola

As has been stated above, in the lines of the ship shown in Figs. 1, 2, 3 and 4 a parabola has been used for the base curve—that is, for the expansion of the bilge diagonal. One reason for the use of this curve in medium speed cargo vessels is the ease with which such curves can be laid out, the ordinate at any frame point, when measured from the half breadth line as a base, varying as the abscissa squared. In other words, the same principle is used as that by which a parabolic arch is laid out.

If other curves are used, such as a trochoid, both for the bilge diagonal and for the load waterline, it might be well within the limits of possibility to develop a hull that would have trochoidal lines throughout. This should be a profitable field for experiment for those schools that possess a model basin.

Crown and Sheer of Deck Eliminated

Turning to other features of standardized ships, it seems quite reasonable to expect that the crown or camber will be eliminated from the deck beams. Another suggestion along this line would be to give the vessel a straight sheer in the dead flat section, and if any curved sheer were considered necessary to satisfy freeboard requirements, to put this in at the ends. This would afford the maximum facility in laying out the central part of the hull, as the work would be entirely rectangular and parallel.

Another feature that should simplify and expedite construction would be to make the floors and tank top parallel and flat and eliminate the centerline vertical keelson. In its place could be substituted an intercostal member and the floors and tank top stiffeners could be carried right through from margin plate to margin plate. This should hasten construction and eliminate quite an amount of expensive work around the center keelson.

There is really no final engineering reason for cutting the floors and then trying to put them together again, and the practice of doing it is simply a relic of the longitudinal system of shipbuilding. Why cut the floors to put them together again, especially when you start with a rolled joint? At best the function of the keelson is nothing more than a distance member and its work can just as well be performed by intercostals. Compensation can readily be made by increasing the section or doubling the keel plate, and perhaps the rider plate. So far as a watertight keelson might be required, the same degree of safety and stability can be obtained by a closer spacing of the continuous watertight floors.

The lines shown in Figs. 1, 2, 3 and 4 are for a vessel 200 feet by 40 feet by 20 feet. The photographs (Fig. 6) are of a model made from these lines, and it is really surprising how pretty a model is obtained from them.

This model was made by Mr. Edward Morris, assistant superintendent of the Chicago Shipbuilding Company, to whom the writer is greatly indebted for his assistance and interest.

New Capacities Attained by Electric Cranes

As a result of the speeding up of shipyards and industrial plants in 1917, there was a greatly increased demand for cranes, electrically operated and controlled. Six of the largest of these cranes were equipped with motors made by the General Electric Company and in most cases with G-E control.

Two cranes were of 225-ton capacity, the total motor rating of each aggregating 420 horsepower; a third crane of the same capacity and motors with a total intermittent rating of 850 horsepower. The two main hoist motors each had a rating of 250 horsepower for continuous and 425 horsepower for intermittent service, giving a hoisting speed for 225 tons of 40 feet per minute and 120 feet per minute for 60 tons.

Due to the high and variable speeds required, the large current demands could not be handled to the best advantage through the usual arrangements of rheostats and contractors, and Ward-Leonard control was, therefore, provided; this being the first application of this system of control on large cranes.

The remaining three cranes were the largest capacity units of this type ever built, being designed for a full load lift with the main hoist hook of 330 tons at 12.6 feet per minute. The power equipment for each crane comprised two 200-horsepower, main-hoist motors, two 105-horsepower auxiliary hoist motors and 80-horsepower and a 30-horsepower motor for main and auxiliary trolley, and two 50-horsepower motors for bridge motion; all these capacities being intermittent ratings.

Two high-speed, alternating-current, hammer-head coal handling gantry cranes, provided with a unique system of dynamic braking, were installed at the La Belle Iron Works plant, at Steubenville, Ohio. Each crane is equipped with a 375-horsepower slip ring induction motor direct coupled to a 40-horsepower, direct-current motor, and hoists a four-ton bucket of coal at 500 feet per minute. The dynamic braking is obtained by combining the small, direct-current motor with the alternating-current motor, so that the direct-current unit serves as an exciter and gives dynamic braking which is comparable with that ordinarily obtained with direct-current motors on this class of work.

This is the first application on any large scale of this system of dynamic braking for cranes, which is more economical in first cost and has a number of practical operating advantages when compared with the method

Hammerhead Traveling Crane Operated by 375-Horsepower General Electric Slip Ring Induction Motor Arranged for Special System of Dynamic Braking

which utilizes a motor-generator set, in addition to an exciter for securing dynamic braking for alternating-current hoist motors. Creeping speeds of 110 feet per minute, lowering, are obtainable with these cranes under ordinary service conditions.

In total, G-E motors and control were installed on more than twice as many applications as in the previous year.

Large Tramp Steamers Recommended for British Inter-Imperial Ship Lines*

Last fall, Premier Lloyd George appointed a special committee, consisting of ministers of a number of government departments, to inquire into and report upon the best methods and machinery by which to give effect to the policy of Imperial Preference in Trade, as expressed in the following resolution adopted by the Imperial War Conference of 1917:

The time has arrived when all possible encouragement should be given to the development of the Imperial resources, and especially to making the Empire independent of other countries in respect of food supplies, raw materials, and essential industries. With these objects in view, this conference expresses itself in favor of the principle that each part of the Empire, having due regard to the interests of our Allies, shall give specially favorable treatment and facilities to the produce and manufacture of other parts of the Empire.

Among the plans of the Dominions Royal Commission for an elaborate programme for the economic linking up of the Self-Governing Dominions with England and the Colonies, were the following:

"1—The establishment, by government ownership or subsidy, of several great lines of steamships connecting the parts of the Empire, and an inter-Imperial scheme of deep-harbor development to accommodate the ships, 660 feet long, with 38-foot draft, calculated to have the ultimate practical economies of freight transportation which would make tariff discrimination unessential in Imperial Preference.

"2—A system of government rate regulation of shipping and marine insurance on routes between ports of the Empire."

What the commission has gathered for its constructive plan of inter-Imperial shipping is particularly impressive. The master-builders of England's great shipyards have contributed their expert advice to the commission, and in one of its recent reports it is shown in tabular form how the cost per ton of freight transportation can be cut to a fraction of the "tramp" steamer's cost by the use of the immense vessels of steam or motor type that the commission recommends. The future may see these ships running regularly, with seasonable variations from one route to another, on lines stretching out from London to the Far East by way of the Cape of Good Hope, on fast mail and freight lines involving a transfer to rail on the Imperial line from London to Halifax or Quebec, thence by rail to Vancouver, thence by great steamer again to Honolulu, Suva and Sydney or to Hongkong. Or it may be along a third projected all-sea route via London, Liverpool, Halifax, Bermuda, Kingston, Panama, Tahiti, Auckland and Sydney, with alternates to Singapore and Hongkong. These will be the heavy "trunk lines" to the Far East with others through the Suez Canal to India and Hongkong.

Information about the results of what is undoubtedly the most comprehensive survey of the capacities of the world's leading ports by this commission has just reached this country. As a result of this survey, the commission is able to ascertain how much money and how much time will be necessary to carry out the programme of harbor improvement along these Imperial routes which will be needed to enable the great ships to keep up steadily the time schedules that will be a feature of their whole economic scheme. Considering the vastness of the idea, the

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* From an article on "The Economic Empire Great Britain Is Welding Together," in *The Americas*, February, 1918.

time and money required seem almost insignificant, as far as the harbor improvements are concerned. And so the commission is now able to go to the British Government, whose Premier is already committed to the plan, with a definite scheme, the biggest problem involved in which is the building of the ships.

Some of the information about the world's port facilities that this commission has gathered is of interest to us. It shows that as a result of our river and harbor expenditures in past years, frequently condemned as extravagant, we have to-day the most comprehensive and uniformly developed system of up-to-date harbors in the world, as far as capacity for accommodating what England is looking forward to as the ships of the future is concerned, awaiting only the mechanical equipment of piers and appurtenances for loading and unloading, which the government here has left to private enterprise. The Panama Canal and our six great harbor systems on the east and west coast can to-day take the greatest ship that floats. We are, therefore, in a position to establish lines of great ships, on our part, if it seems of advantage to do so.

Correlation of England's Harbors

England's ports that lead in the handling of the bulk of highly organized overseas trade are able to take the contemplated big ships now, at high water, and a minimum of expenditure in England is necessary for carrying out the plan of correlation of harbors. In the routes to the East, the Suez Canal, which is now 30 feet deep and will be 33 feet deep as soon as improvements now in progress are completed, will be unable to accommodate the standard ships of 660 feet length and 38 feet draft, but would be used in connection with a subsidiary route to India and the East, with the main ocean track rounding Cape Horn on the way to Australia. Aden, Bombay, Calcutta and Colombo, on the Suez route, are now also limited in capacity for deep-draft ships, but Singapore, Hongkong, Melbourne, Sydney and Hobart will receive the deep-keeled vessels. Capetown and Durban, on the outside route, need only minor development for use by the greatest ships. On the routes to the West, Halifax and Quebec have harbors equal to handling the largest ships. Vancouver and Prince Rupert have also deep harbors. Honolulu can now take ships of only moderate draft, but is being deepened. The harbor of Tahiti is deep. On the Western route proposed *via* the Panama Canal, the Kingston harbor is the only one in which there is not now at least 40 feet of water at ordinary neap tide, and sufficient depth at the docks for the great economic freighter of the future. It is of interest to know that neither Hamburg nor Bremen can accommodate such ships now, but Bremen is supposed to be conducting improvements that will deepen the Weser to 33 feet at low water, and Hamburg is deepening the Elbe to 33 feet depth, low water, with basin accommodations of 36 feet. Antwerp, Havre and Rotterdam are all scheduled for improvement up to the capacity of the contemplated steamships.

As said before, the whole plan hinges on the irresistible economies of big ships, particularly in the case of coal-burning ships. On the economies of these the commission has found:

Unrestricted Draft Necessary

The conclusion that unrestricted draft is necessary for economic transport can be arrived at from first principles. A vessel constructed of a depth sufficient to go to, say, 40 feet draft does not cost so very much more than a vessel of a depth constructed to go to 29 feet draft, whereas the increase in weight of cargo is the difference between the extreme draft of the vessel and the draft the vessel must have in order to float her hull, and machinery, and coal, and stores.

Supposing two ships are constructed, the one of 29 feet draft and the other of 40, and in each case the draft necessary to float hull, machinery, etc., before paying cargo can be put in, is 23 feet. In the one case there is only 6 feet of draft available for paying cargo, whereas in the other case there is 17 feet. The weight of hull for the restricted draft vessel increases much more rapidly than the displacement. The beam cannot be increased in the same ratio as the length, or the stability conditions will be interfered with. Before a great length is reached the deadweight that can be carried no longer increases as the length of vessel increases, but begins to decrease. Farther, the excessive proportion of breadth to draft in the large vessel of restricted draft is bad from the point of view of resistance and therefore the running costs, which depend on the power of the machinery, are considerably increased.

With Unrestricted Draft Cost of Transport Steadily Decreases With Increase of Length

Following out this principle, Sir John Biles supplied various practical and very striking illustrations. He found that if draft were unrestricted the cost of transport steadily decreased with increase of length; thus a vessel 700 feet long, with proportionate draft, could transport goods on a 3,000-mile voyage at a speed of 14 knots, 13 percent cheaper than a smaller vessel of 490 feet in length, while further increase in speed in the larger vessel would be less costly. He also found that increase in length is uneconomical unless accompanied by adequate draft; thus, with draft restricted to 23 feet 3 inches, the cost of transport per ton for a voyage of 3,000 miles by a vessel 700 feet in length would be 50 percent greater than if the same vessel had its full proportionate draft; in fact, increase of length without proportionate increase of draft not only does not diminish cost of transport, but actually increases it.

Recommendations

The plan involves considerable improvement of English harbors, although the survey shows that even now ships of the size desired may enter London, Liverpool and Southampton harbors at the height of the daily tides and be placed in deep berths. It is suggested that the present system of local control of harbors be modified in order to enable the government to carry out the national policy. It is also recommended by the commission that an Imperial Development Board, which it proposes as a means of co-ordinating the efforts of all the British nations, should be given power to regulate ocean rates and quality of service, whatever way it may be finally decided for the governments to establish the inter-Imperial system of ships.

If even a very small steam leak develops in the piping or engine, get after it at once. It is likely to grow worse and always at an inconvenient time.

A wood screw which cannot be started can easily be removed by heating a piece of iron or steel red hot and holding it against the head of the screw for a short time. It expands the metal and so loosens the screw.

What is Happening With the World's Great Merchant Commerce?*

Growth of World's Merchant Marine—Regular Steamship Lines and Tramp Ships—Machinery of Ocean Transportation Wrecked by the War

IN the twenty-five years just preceding the war Europe built up an interlocking, internationally co-operative machinery of trade, industry and transportation, and by commercial diplomacy made the necessary concessions and arrangements in tariffs to permit the machinery to work economically. The whole world, the United States included, took a part in certain phases of this arrangement.

First, there was the machinery of ocean transportation. It was steadily growing to be an international machinery, although the individual nations were strengthening their merchant fleets for exclusively national purposes and taking a more and more advantageous position in trade by doing so. In 1880 England carried 70 percent of the commerce entering and leaving her ports in her own ships, 30 percent of it going in foreign vessels. In 1912, with nearly three times as great a tonnage of shipping going in and out, she carried only 58.2 percent of it and allowed 41.8 percent to come and go in foreign ships. We find Germany, with a great increase in her own shipping and a growth of commerce that caused the tonnage that entered and cleared her harbors to grow from 13,066,412 in 1880 to 49,460,469 in 1911, increased the proportional business of her own shipping in her commerce from 39.1 to 50.3 percent. British ships had carried 38 percent of the German commerce in 1880, and their part decreased to 23 percent. The growing fleets of other nations increased their activities as carriers of German commerce from 22 to 26 percent. The growth in the co-operation of the maritime commercial nations in each other's transportation is shown by the following changes in proportionate tonnage:

	Total Tonnage Entered and Cleared	Own Tonnage Percent	British Tonnage Percent	Other Tonnage Percent
United Kingdom, 1880	58,736,063	70.4		29.6
1912	152,457,045	58.2		41.8
United States, 1880	30,547,026	20.4	51.7	27.9
1912	69,365,104	13.5	52.3	34.2
Germany, 1880	13,066,412	39.1	38.1	22.8
1911	49,460,469	50.3	23.0	26.7
Russia, 1885	10,792,894	8.7	49.7	41.6
1911	27,738,433	10.9	32.1	57.0
Norway, 1880	3,985,477	68.2	11.8	20.0
1911	10,230,279	52.7	9.8	37.5
Sweden, 1880	6,894,155	37.2	13.5	49.3
1911	23,390,647	49.8	5.4	44.8
Denmark, 1880	4,523,643	52.1	11.4	36.5
1911	17,144,432	54.2	5.1	40.7
Holland, 1880	6,844,037	30.9	49.8	19.3
1911	30,847,855	26.6	30.5	42.9
Belgium, 1880	7,116,146	11.6	59.4	29.0
1912	32,672,986	11.4	43.2	45.4
France, 1880	25,032,478	30.0	40.6	29.4
1911	61,366,051	24.0	36.1	39.9
Italy, 1880	9,846,970	34.8	34.3	30.9
1911	51,851,528	27.0	28.7	44.3
Japan, 1900	19,661,602	34.9	38.9	26.2
1912	43,492,604	47.6	30.4	22.0
Argentina, 1880,	2,242,582	11.1	37.8	51.1
Argentina, 1880	2.242,582	11.1	37.8	51.1
1911	25,981,569	43.4	33.5	23.1

The ocean shipping of the world was steadily trending to the establishment of extensive systems of regular lines and of shipping consolidations and conferences, these having great speedy ships on certain routes, with economics of regulated transportation on a large scale; but there were "feeder lines" of smaller boats, and many cargo ships directly owned or chartered that looked out for the carriage of bulky commodities in full-ship quantities by direct voyages, and for the transportation of the seasonal movement of wheat, cotton, hides, etc. There was still the army of "tramp" ships that "found" their cargoes as they went from port to port. Liners and all, however, gave an international service, and the great mercantile ports on the Channel and the North Sea were ports of call. Ships of all nationalities in late years were given access on equal terms and thronged the ports of the great maritime nations of Europe. The tables of statistics showing the tonnage of entrances and clearances in London and the other ports are dry-looking things, but when they are understood and read with some imagination they tell a very interesting story of the great procession of ships, both steam and sail, as they made the round of the harbors and then "stood off" on the long voyages to distant ports, returning by triangular routes, as the stream of shipping, looked at as a whole, carried the heavy tonnage of outward-bound European products to certain parts of the world and then circled about to other producing countries to load the bulky current of the materials Europe imported. It is a picture of the "organization" of ocean shipping, and in it we can see two apparently contradictory developments harmonizing with each other. We can see how the nations that maintained or were building up their merchant shipping wielded a strong influence on the commercial situation proportionate to their marine, and at the same time we can see that all the nations used the ships collectively and in a kind of co-operation. The same intelligent national self-restraint by which intense competition and shrewd co-operation at advantageous points were exercised together shows also in the international use of other institutions of commerce before the war.

During 1917, when the U-boat campaign had its fullest effect in interfering with the organization of ocean shipping and England began to sacrifice trade supremacy to the necessity of concentration upon the war, a decided change in the British system of mercantile re-exportation took place, accentuating a slow development that was already in progress. We are to-day obtaining direct from the sources of supply in British colonies and in countries that formerly sold through London much of the raw materials we formerly obtained in England and in other markets of Europe. In immense tonnages, rubber, tin, hides, wool, etc., have been coming to us direct from the Indies, South Africa, South America, etc., which we formerly bought as re-exports in London, Antwerp, Rotterdam and Hamburg.

When the war ends there will almost inevitably be a disposition of the world's ocean-shipping tonnage very different from what it was in 1913 or what it is now. It has been predicted that the merchant shipping of the United States will be as great in tonnage as that of England. With any such growth of our shipping as is predicted we will surely establish a new system of ocean routes focusing upon our own national harbors. It is proposed that New York shall be made a "free port," which will be an encouragement for our own re-export business, which has already grown from $37,377,791 (£7,650,000) in 1913 to $63,036,795 (£12,900,000) in 1916, and is taking on the

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* From *The Americas.*

typical character of a merchandising trade. We are building up typical world-wide merchandising organizations of our own and great London houses are putting branches in New York in anticipation of our sharing at least with England a world-wide organization of ships and commerce.

Germany has lost her organization. The Scandinavian ports are ambitious to locate permanently the Baltic collection and distribution that Hamburg and Bremen used to all but dominate, deferring only to London's commercial power. The British government, in its exercise of war control over trade, has done much to disorganize the London and Liverpool machinery of mercantile commerce. There is great likelihood of a British inter-imperial policy of economic union which will establish either preferential tariffs or attempt to organize government-owned agencies of transportation, etc., favoring inter-empire industry and exchange of products. Everything points to a British intention to take full advantage of the fact that the lion's share of materials needed in modern manufacture are produced, or till now at least have been produced, in the colonies and dependencies.

The war has now made a complete wreck of the machinery, commercial treaties and trade good-will by which the nations in Europe co-operated in furnishing each other with materials, in the processes of manufacture, in selling and transporting. England is on the point of adopting legislation that will shut individuals of "enemy" birth, even naturalized as Englishmen, out of her markets after the war. The little nations and the colonies that did their marketing through European centers have established direct connections. We are getting much of the raw materials we import to-day through the mercantile organization of England but by direct shipping transportation. We have taken over with her whatever is left of British co-operative connections in international commerce. We are expanding our commercial organization and building many ships. What kind of a world organization of commerce will rebuild out of the pieces of the old nobody knows, but it looks very much as if the United States would be in a position either to conduct a pretty capable machine of our own or co-operate with England and our other associate nations in the building of a bigger international machinery than existed before. If we do build up a new co-operation that excludes any other nation, for any reason, it will be a handicap in the rehabilitation of that other nation's own industries, as well as its foreign commerce, not to be lightly considered.

Rain and Spray Excluding Fan for Ship's Port-Holes

To provide a ventilating apparatus to admit air to the cabins or staterooms of a steamship, but at the same time to exclude rain or spray, W. J. Baldwin, consulting engineer, New York, has designed the machine shown in Fig. 1, consisting of an outer casing made to fit the port holes or deadlight frame and containing an electrically driven fan, to the blades of which a flying band of perforated metal is attached. The fan draws the air through the port-hole, but any rain or spray or heavy particles in the air are carried against the inner side of the perforated metal band, where they are thrown into the casing and discharged through an outlet at the bottom.

The apparatus illustrated, which weighs only about 50 pounds, was used continuously for seven months on the steamship *Munamar*, of the Munson line. When first used the light-shield shown in the illustration was not provided, as this was installed after the outbreak of war, in accord-

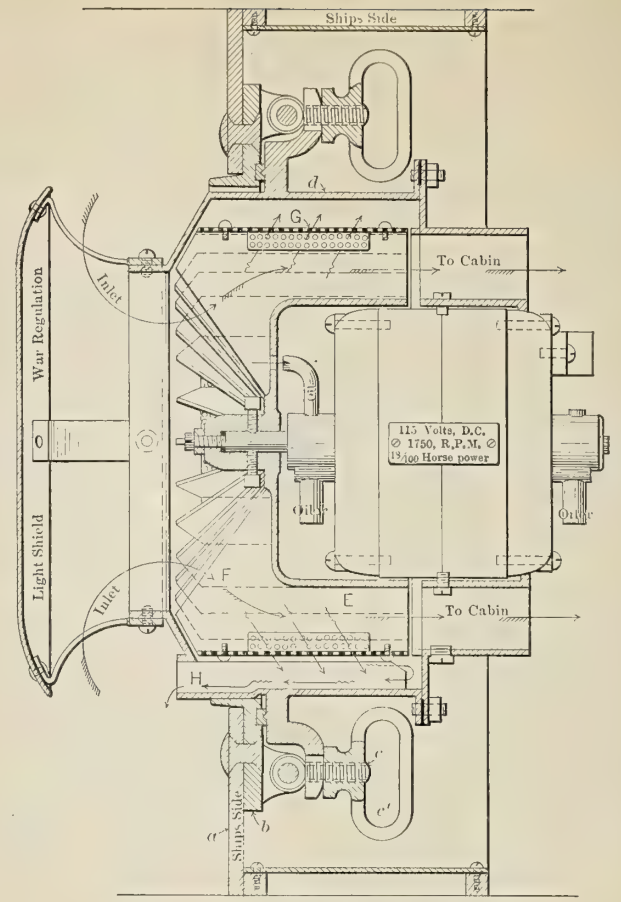


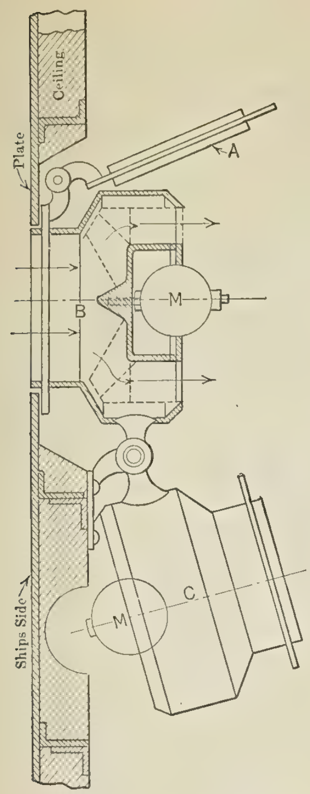
Fig. 1.—Rain and Spray Excluding Fan

ance with war regulations, and is merely for the purpose of darkening the ship at night to aid in eluding submarine attacks.

The apparatus is hinged to the brass frame on the ordinary deadlight, so that when the glass is swung away and the port opened the machine is swung into place and made tight on a rubber gasket with the same hand screws that are used when the port-hole is ordinarily closed in bad weather. The apparatus has the advantage of being portable and may be used in any deadlight or side light of a stateroom, bathroom or lavatory on the vessel. The one installed on the *Munamar* was never closed, as it was simply moved from the weather side to the lee side of the ship as occasion required.

While conducting experiments to produce a system for removing dust from air by the means of a water spray it was discovered that the water spray actually dried the air that passed through the machine, as well as precipitating the dust. The discovery of this method of drying air economically was a step in the process and led to the design of an apparatus shown in Fig. 3, the object of which is to regulate the hygrometric conditions of the air within an inclosed space. It was found that the action of the machine not only threw out the water fed into it, but was actually taking the excess moisture from the air. This led to the design of an apparatus that would keep the air in a radio room at a fixed condition of humidity, and it was found that it was only necessary to fix the temperature of the water fed to the machine to get any degree of dryness or, for that matter, of dampness in the air. Cold water would produce dryness and warm water would give any degree of humidity by regulating the temperature of the water.

In addition to excluding water, the apparatus prevents



A—DEADLIGHT OPEN.

B—SPRAY, OR RAIN, EXCLUDING FAN IN DEADLIGHT PORT.

C—POSITION OF FAN WHEN NOT IN USE.

Fig. 2.—Rain Excluding Fan Hinged to Frame of Ship's Deadlight

the passage of dock or cargo dust into the ship, and as well kills all insects, throwing them out of the port-hole with the dust.

The electric motor which operates the fan is inclosed in the center of the apparatus, entirely away from the action of the air or water. Seven months' usage of the apparatus on the *Munamar* showed no deterioration either in the apparatus or the motor.

Fig. 3 shows one of the devices designed for the roof of a radio cabinet. In this case the machine has to be systematically supplied with a water spray and with means for carrying away the water. For this purpose the ordinary ship supply can be used, as two ounces of water per minute is ample for the radio cabinet, such as is used on a ship.

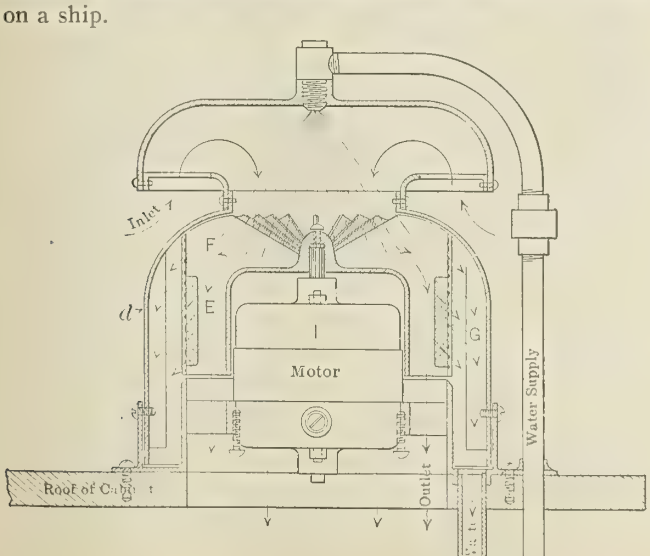


Fig. 3.—Hygrometric Regulator for Radio Cabinet on Board Ship; Capacity, 7,000 Cubic Feet Air per Hour; Power Required, 0.042 Horsepower.

The capacity of the apparatus designed for a port-hole is 36,000 cubic feet of air per hour, and the static air pressure exerted by the fan is from ¾ to ⅞ inch of water. No special wiring is required, and the power required by test is only 0.18 horsepower. The apparatus designed for the radio room will discharge 7,000 cubic feet of air per hour and requires only 0.042 horsepower.

Further Notes on Forced Draft

BY C. H. WILLEY

SINCE completing the series of articles, "Duties of Newly Trained Marine Engineers," the writer has received a communication from the office of James Howden & Company, Ltd., original patentees and manufacturers of the Howden system of forced draft, in which they comment on that part of my third article concerning forced draft. They inform me that when firing, the draft is cut off (as I stated in my article) to prevent "flare-backs," but the ash pit doors are not fitted with any automatic locking device where they supply the furnace fronts.

The furnace door, however, is so arranged that it cannot be opened until the draft is completely cut off. Furthermore, this control (single lever) regulates the entire supply of air to the ash pits.

The sketches show the type of front supplied only through James Howden & Company, Ltd. They have found that very little amount of fan blower control is required under normal circumstances, having learned through experience that the valves on the furnace fronts can be operated to give the best results.

In systems fitted by them, they do not employ a damper in the ash pits. When operating under natural draft, the ash pit door is lifted up, or door opened only.

The following additional notes and instructions for engineers operating the Howden system of forced draft will be found very valuable.

Fire Bars and Furnaces

1. The side bars must be fitted *close to the sides of the furnace* so as to prevent air from passing up at the sides. Asbestos cement, or other suitable material which hardens under heat, should always be kept in the recess made for the purpose. The dead plates must also be air-tight at the sides, and the recess filled with the cement.

2. Care must be taken to have all the fire bars fitted so as to have *no slackness sideways* when working.

3. Thin bars should be used to pack the bars sideways should the last bar of the ordinary thickness to be put in be too thick for the space. The proper allowance for expansion of the bars under heat must be given lengthways.

4. *No air whatever must be allowed to pass through the bridge from the ash pit.* Air must pass from the ash pit through the fire grate only.

Note.—If the tubes are clean when starting, the boilers may run with the retarders continuously for a fortnight, if the fires are properly worked, before requiring to be cleaned.

Firing

The highest evaporative power combined with the highest economy will be obtained with the least labor by carefully attending to the following directions:

1. In firing, the coal must be maintained *nearly level across the furnace, and always a good height at the bridge.*

2. *The coal must not be heaped up in front, as is usual in natural draft boilers, or lie against the cast iron boxes inside the furnace fronts.* When the fire is too high in

front, the air from the cast iron boxes at the sides of the furnace, and from the box on inside of the furnace door, is prevented from striking over the surface of the fuel and effecting its proper combustion. Heaping coal up near the furnace door also destroys the air boxes, and consequently causes the admission of too much air to the furnace without increasing the combustion. All unnecessary use of air in the furnace wastes fuel. The air boxes at the sides of the furnaces, and on the inside of the furnace doors, should keep in order for a year if the firing is properly done.

3. *The fires should never be so thin as to allow air to pass up too freely through the fuel, nor should the fires be too thick to prevent the ignition of the fuel all through.* When a high rate of combustion is being used, the fires should be somewhat heavier. The depth of the fires should also be in proportion to the diameter of the furnaces. The larger the diameter, the deeper the fire. When thick fires are used, the occasional use of the slice becomes advantageous.

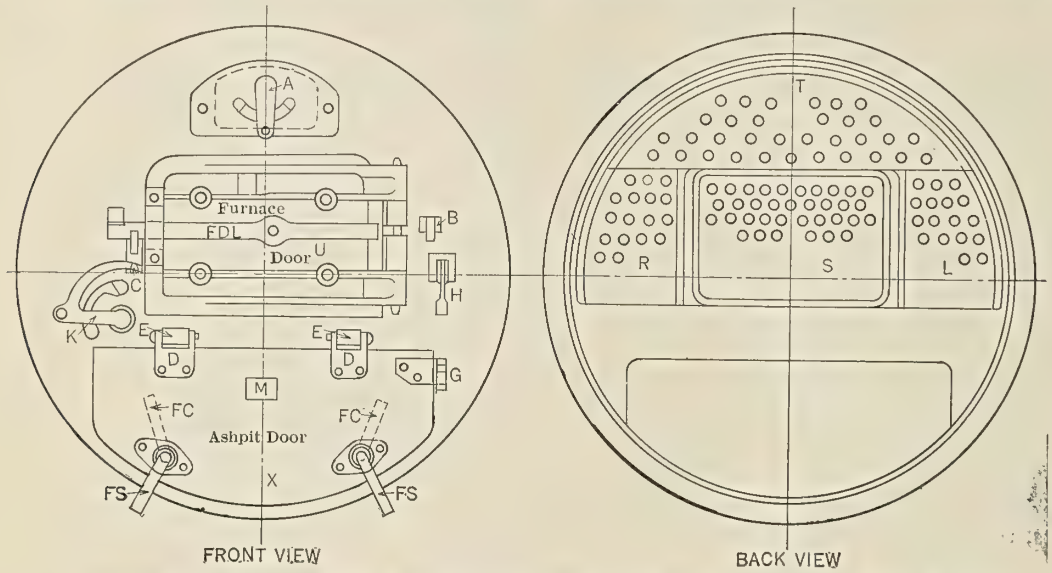
4. As the coal burns more quickly at the sides and the back, *care must be taken to lay the coal well in at the sides in firing,* and to push it back when leveling before firing. *The bars should never be bare at any part of the grate,* as this allows large quantities of air to pass through and cool down the burner.

5. If the fires are burned down irregular in thickness, they should always be leveled up with a light rake before firing. When this is regularly done the surface of the fires will always be kept in good order.

Note.—Heavy smoke with distillation of gas and production of soot, causing deposits of tar and soot on the back tube plates and in the tubes, and which sometimes also causes flaming in the uptake and funnel, is entirely due to the coal being allowed to lie in a dead mass without a sufficient quantity of air being passed through it. This is sometimes caused by the want of sufficient pressure of air in the reservoir. Also by air passing from the ash pit at side bars or elsewhere, or not wholly through the air spaces in fire grate.

Cleaning Fires

1. All the fires must be cleaned from the top and *never pricked from below.* Pricker blades should not be allowed on board. When the light is not seen shining through the bars from the window in ash pit door, the fire is either too thick and requires to be opened up from above by the slice, or clinker has formed on the fire bars, preventing the passage of air through the coals. The heavy slice must then be used and the sharp chisel end made to pass over the top of the fire bars and lift up the clinker from them, turning it on edge. The furnaces may be worked with a good deal of clinker if it is not allowed to lie flat on the bars. The mica window on ash pit door, if kept clean, shows when the fires require slicing. So long as the light shines through the fire bars into the ash pit no slice is required in the furnace. Examination through the window will generally show the part of the grate where the combustion is most retarded.



Mountings for Furnace Fronts in Connection with Howden's Patent System of Forced Draft

A, Top Valve Handle. B, Back Catch. C, Front Catch. D, Hinge Flat. E, Hinge Center. FC, Ashpit Door Handle for Center Front. FS, Ashpit Door Handle for Side Front. G, Catch for Ashpit Door. FDL, Furnace Door Latch. H, Hanger for Ashpit Door. K, Slide Valve Handle. L, Left Hand Baffle Plate (or Air Box). M, Mica Plate. R, Right Hand Baffle Plate (or Air Box). S, Door Baffle plate (or Air Box). T, Top Baffle Plate (or Air Box). U, Furnace Door. X, Ashpit Door.

Working Air Valves

1. In working the air valves, it is understood that the *air pressure in the main discharge pipe from the fan is not under two inches,* and it may rise to four inches if the quality of coals or rate of combustion require it. If the pressure in the air pipe is too much for the requirements in the furnace with both ash pit valves opened, then these valves should be partly shut.

2. The top air valve, which is for the purpose of consuming the gases and reducing smoke, should not be shut when firing or even in cleaning fires. It should be set by the engineer to suit the kind of coal being used when starting, and never moved during the voyage unless to prevent steam blowing off when the engines are stopped, and even then not entirely closed. With the best coal one-third to one-half open is sufficient, but a greater opening is required for highly bituminous smoky coal. When this valve is open more than necessary it tends to reduce economy.

3. When steam is rising faster than is wanted, the ash pit valves should be partly shut.

4. When working natural draft *shut ash pit valves, open ash pit door, and keep the upper valve full open.*

Note.—Never open the furnace or smokebox doors to

keep down steam, as the combustion is perfectly controlled by the air valves.

Be careful when working to have the furnace and ash pit doors perfectly closed.

Working a Number of Boilers Together

To maintain a constant and full supply of steam when working a number of boilers together, each fireman should work the furnaces under his care as if there were no others in the ship.

As each fireman will use different quantities of coal, and will give the fires different treatment, a number of men firing merely by rotation will tend to bring the fires into an irregular and unfavorable condition.

The cleaning of fires should not, therefore, always be left to be done at a given hour. Some coals very soon run a clinker over the bars and prevent combustion from below, which may reduce the effect of the furnace from one-half to two-thirds. Whenever the mica windows (which should always be kept clean) do not show the light shining in the ash pit, the slice must be used to lift the clinker from the bars.

It is not always necessary to remove all the clinker. If it is turned on edge it will not hinder combustion, and it can be removed at convenience. The frequent use of the slice to clear the fire bars from clinker and partial cleaning of fires whenever required, will always keep the fires in best condition and make the thorough cleaning of the fires at the usual intervals a much lighter operation, which should occupy a few minutes' time.

Cleaning fires with this forced draft should in no case cause any drop in steam pressure. Though one fire in each boiler was being cleaned simultaneously, the steam pressure should be fully maintained.

This is easily accomplished by observing the simple rule that no fireman begins to clean a fire until the other fires under his care are put in good condition, with a proper charge of coal on each and full air pressure below bars. Following this course in some steamers with single boilers having three furnaces only, the engines are maintained at full speed and the safety valves made to blow off while cleaning fires. An equal effect should be aimed at also in high-powered steamers with many boilers.

Treatment of fires, whether in firing, slicing, dressing or cleaning, should be done rapidly. Far too much time is generally taken sorting fires.

Suitable tools for each fireman should always be lying at his hand so as to prevent loss of time in completing his operations.

Following these instructions, every fire should always be in good order and steam plentiful.

These instructions were received by the writer from the manufacturer of the Howden System.

Furnace Design Can Be Improved

The Bureau of Mines, Department of the Interior, after several years of experiments in fuel combustion in a special furnace, makes the announcement that, from the results, it is possible to design a furnace with considerably more assurance as to its capabilities than has heretofore been possible.

Starting with the analysis of the coal to be used and the rate at which it is to be burned, the furnace dimensions in feet and inches can be designed with a reasonable assurance of obtaining a desired degree of completeness of combustion.

The bureau has just made a report on this subject, Bulletin 135, "Combustion of Coal and Design of Furnaces," by Henry Kreisinger, C. E. Augustine and F. K. Ovitz. The publication marks a period in work approved in 1906 by a National Advisory Board appointed by the President to advise the Government concerning fuels. The bureau proposed to conduct such experiments as would make it possible to design fuel-burning furnaces on a rational basis rather than by the cut-and-try methods of the past. The process carried on in the combustion space is influenced by many factors, the most important of which are the volume and shape of the combustion space; the kind of coal used, especially the character and amount of volatile matter it contains; the rate of firing; the quantity of air supplied over the fuel bed; the rate of mixing the air with the combustible rising from the fuel bed; the rate of heating the coal; and the temperature in the combustion space.

The qualitative effects on the rate and completeness of combustion of many of these factors have been known for a long time; but the quantitative data, presented in definite units, of seconds, pounds, feet, or percentages, have been lacking. To obtain such definite information, a study of combustion in the space beyond the fuel bed was undertaken, and the results of extensive tests are given in this bulletin. About 100 elaborate tests were conducted in a special furnace using three kinds of coal—Pocahontas, Pittsburgh, and Illinois—and at rates of combustion covering the full range found in practice. These are believed to be the most extensive tests of the kind ever undertaken.

While the bulletin is especially for those interested in the design or reconstruction of fuel-burning furnaces, it contains much of interest to the general engineer interested in fuel problems. Some of the statements sure to arrest the attention of the interested engineer are as follows:

The size of the combustion space required appears to be directly proportional to the percentage of oxygen in the moisture-free and ash-free coal.

The percentage of excess air that gives the best results varies with the size of the furnace and the kind of fuel. This fact explains why in one plant the highest efficiency may be obtained with 14 percent of CO_2 in the gases, and in another plant with only 10 percent of CO_2.

There is a definite relation for each coal between the excess air supply and the percentage of CO_2 in the furnace gases.

Soot is formed at the surface of the fuel bed by heating the hydrocarbons in absence of air. It is not formed by the hydrocarbon gases striking the cooling surfaces of the boiler. As a matter of fact, only a very small trace of the hydrocarbon gases ever reach the surface of the boiler. Hydrocarbons that do so are prevented from decomposition by the cooling effect of the contact. The cooling surfaces do not cause the formation of soot; they merely collect soot and prevent its combustion.

It seems that most mechanical stokers are smokeless, not because they burn the smoke, but because they burn the coal in such a way that very little soot or smoke is produced. Hand-fired furnaces are smoky because soot is produced in or near the fuel bed, and cannot be burned in the limited combustion space of the furnace.

Copies of this publication may be obtained free of charge by addressing the Director of the Bureau of Mines, Washington, D. C.

The design of metallic packing is important, yet the material of which it is made is of equal moment.

Why Is Tonnage?

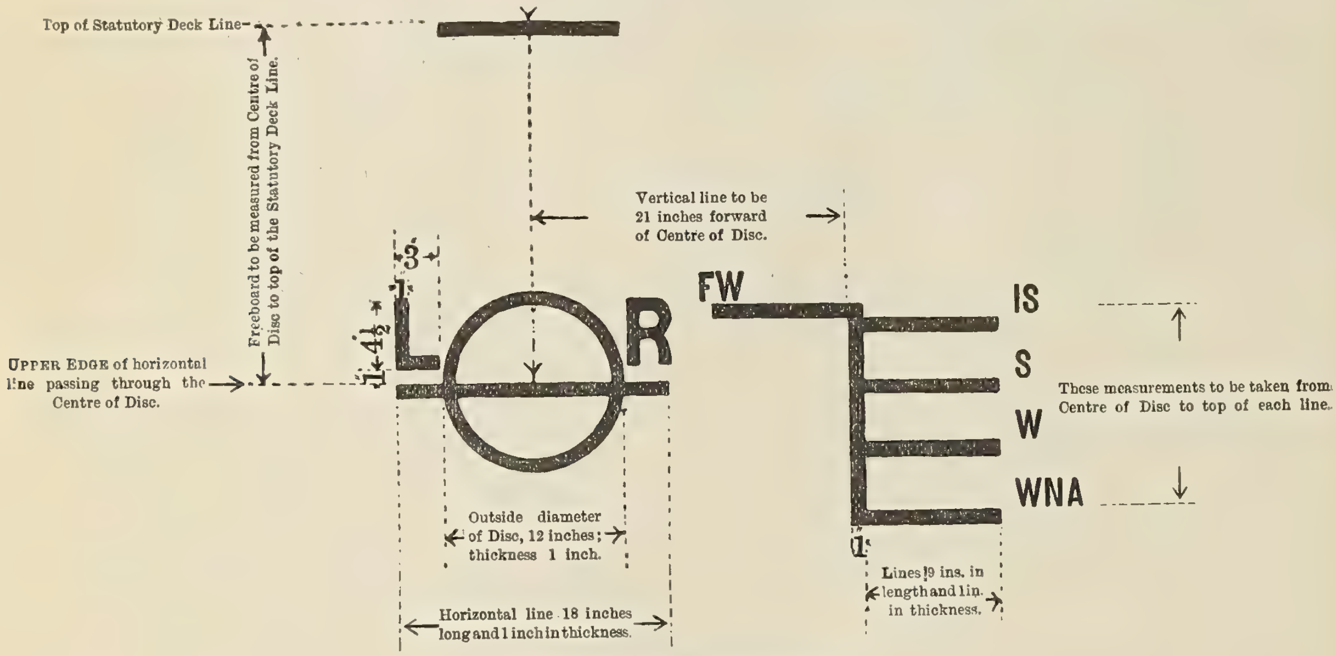
Mac, the Veteran Ship Draftsman, Explains the Various Systems of Measuring Vessel Tonnage

"MR. MAC, we were down on the dock this noontime taking a look at that tank that is going away next week. Somebody wanted to know what it costs to dock a ship like this. The dockmaster told us that for a ship of this size it costs twenty-four cents (1/0) per ton for the first twenty-four hours, and eighteen cents (0/9) per ton each twenty-four hours afterwards. There is no charge on Sundays and holidays, if no work is done on the ship. Then somebody wanted to know how many tons? The dockmaster did not know. I have looked it up, but am about as far away as I was before. She displaces 15,000 tons, has a deadweight carrying capacity of 10,000 tons, has a gross tonnage of 7,000 and a net tonnage of 4,500. Why is tonnage, anyway?"

"Well," replied Mac, "the charges on this dock are, as I remember, based on gross tonnage. This would make a charge of $1,680 (£344) the first day and $1,260 (£258) afterwards. Net tonnage could have been used as a basis of charging, as in the case of canal tolls, but gross tons seem to be the style around here. With net tonnage the rate per ton would be higher and maybe the reason can be found in this, that the use of gross tons gives a low rate per ton and it sounds cheap. Some real estater is able to prove that it is cheaper to dock a ship here than somewhere else where net tonnage may be used as a basis. Of course, it costs the same in either case.

"Displacement and deadweight carrying capacity are measured in long tons of 2,240 pounds; 2,000 pounds is a short ton, and 2,204 pounds, or the weight of a cubic meter of fresh water, is a metric ton.

"Gross and net tonnage are measured in tons of one hundred cubic feet of enclosed space in the ship. There are 44 cubic feet in a ton of coal, 40 cubic feet to the ton of package freight, and water occupies 35 cubic feet to the ton, so that this ton of 100 cubic feet needs explanation.



Lloyd's Freeboard Marking for Steamers

"In England in 1854, when the matter of tonnage was under discussion, it was found that the registered tonnage of the entire British merchant marine was 3,700,000 tons, according to the then existing measurement rules. The actual cubic contents was estimated at the same time to be 363,400,000 cubic feet. A ratio of 1 to 98. With the idea of keeping the registered tonnage about the same as it had been and at the same time simplify calculations, the gross ton was officially made 100 cubic feet of enclosed space. The United States adopted this measurement standard in 1864, and now it is universally used.

"Gross tonnage, then, is a measure of the enclosed space in the ship. Net tonnage is gross tonnage after certain deductions have been made of spaces which are not permanently enclosed or cannot be used for carrying cargo.

"The measurement of gross tonnage is described in detail for all classes of ships in a United States Department of Commerce publication called 'Measurement of Vessels.' These rules are unhandy and I always feel that I have more than earned my money any time I have to refer to them. They are tough. Of course these rules are intended for Government surveyors or inspectors, but in the case of a steel ship the drawing office usually gets up a tonnage drawing showing the principal dimensions of the ship and sections, so that the gross tonnage can be calculated. We generally do the calculating also.

"Part of the enclosed spaces on a ship are supposed not to be used for carrying cargo, and are therefore deducted from the total or gross tonnage. The engine space, living quarters, bosuns' stores, etc., are such spaces. Steward's stores, refrigerating spaces, etc., are not deducted because they can be used for stowage of cargo.

"Most charges, such as canal tolls, pilotage, towing charges, etc., are based on net registered tonnage, so that it is not surprising that all the slick ones, the fellows who

were bitten in the ear by a fox when they were very young, are trying to beat net registered tonnage. The more space that is exempted or deducted, the smaller this net tonnage and the less the taxes or charges against the operation of the ship. Spaces are exempted for purposes for which they are not used. Rooms for non-resident doctors, pursers and freight clerks may be used as storerooms.

Tonnage of 'Tween Decks Space

"The most notable exemption and evasion of the spirit of the law is that of the 'tween decks space that is supposed to be opened to the weather by tonnage wells, tonnage openings, freeing ports and scuppers. These openings can be covered by planks and tarpaulins and the freeing ports and scuppers plugged. The space is made as dry and secure as any unexempted space.

"As I remember it, the law says that any permanent closed-in space on the upper deck and available for cargo shall be added to the tonnage. The evasion of this rule hinges on the interpretation of the meaning of the words "permanent closed-in space." Fitting of such tonnage openings became a regular practice until exemption was refused for a 'tween decks space on a Scotch-built steamer named the *Bear*. An English decision in the House of Lords sustained the owners of the *Bear* in their claim for exemption, and to-day similar spaces are regularly exempted. 'Measurement of Vessels' gives rules, etc., showing in detail the proportions, etc., for the tonnage well and tonnage openings for securing this exemption.

"A plan showing these exempted spaces is made for the convenience of the measurers who certify the spaces to be exempted, and a list of labels or signs is gotten out for the purchasing department to buy uptown those black and white enameled signs you see over the doors.

Deadweight Scale

"On a capacity plan made for the use of the owner of the ship is usually shown what is called a deadweight scale—a vertical draft scale alongside of a displacement scale. The zero of the deadweight scale is opposite the light draft of the ship. The upper limit is the full load draft, and the corresponding carrying capacity in long tons. This, of course, amounts to the displacement at full load minus the displacement at light load. Sometimes three scales are shown. The draft is in the middle, deadweight carrying capacity on one side and tons per inch on the other.

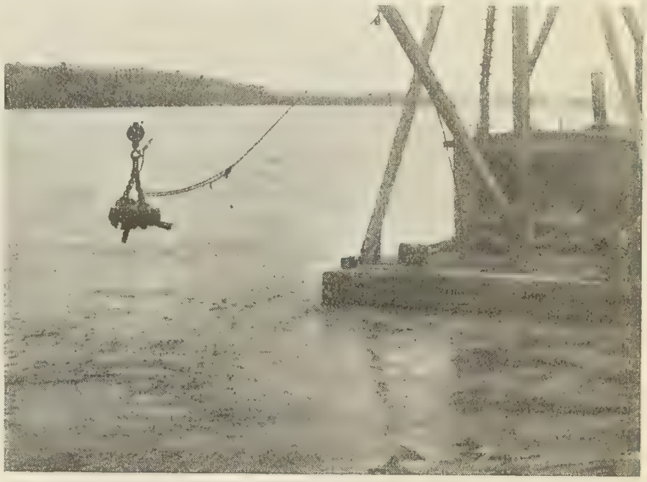
"The full draft is determined by what is known as the freeboard marking for steamers or sailing ships, if the ship is built to Lloyds. Our American Bureau so far has no such marking. A committee of Lloyd's Register assigns this marking to British ships. It is the waterline mark you have seen on the shell of a ship amidships. It is fully described in the back of Lloyd's rules and regulations. When the ship has been surveyed Lloyds sends out a letter having a marking of this kind stamped on the reverse side and properly filled in so that the marking can be cut in and painted white on the shell of the ship. The marking for a steamer is shown in Fig. 1.

"The *L R* stands for Lloyd's Register. *F. W.* means fresh water; *I. S.*, inland sea; *S.*, summer; *W.*, winter, and *W. N. A.*, winter in the North Atlantic Ocean. The idea is that a ship should have more freeboard in rough weather and that she will draw more in fresh than in salt water.

"There was a ship in port the other day that brought 12,000 tons of cocoanut oil and several tons of rice and only registers about 5,000 net tons. Lumber schooners that carry 1,500,000 board feet of lumber often register only 1,250 gross and 700 net tons. A large part of their cargo is not enclosed, hence the great difference."

Sunken Cargo of Pig-Iron Recovered by Lifting Magnet

The Arrow Transportation Company, operating a line of barges on several of the southern rivers, lost one of its barges in the Tennessee River near Paducah last March. This barge, loaded with about 420 tons of sand-cast pig-iron, collided with the pier in the river, and the barge began listing, dropping its load gradually and, therefore, strewing the pig-iron along the bed of the river for a distance of about 100 feet or more.



C-H 43-Inch Magnet Bringing Up a Load of Pig Iron from the River Bottom

The loss represented about $10,000 (£2,050), and the insurance company paid over this amount to the Transportation Company. The insurance company later made arrangements to recover what they could of the cargo by means of a barge and a C-H lifting magnet, purchased from The Cutler-Hammer Manufacturing Company, of Milwaukee. By letting the magnet down to the bed and dragging it along in the vicinity in which the material had sunk, over 90 percent, or approximately 400 of the 420 tons, was recovered.

The cargo was not only saved, but, because of the rising cost of pig-iron, it was sold for $16,000 (£3,280), while the total cost of recovering, including the rental of barges and the purchase of a magnet, amounted only to $4,000 (£820), which gave the insurance company approximately $2,000 (£410), plus a lifting magnet, which has since been put to use in salvaging other lost cargoes. The magnet used was 43 inches in diameter, and of the standard C-H type, which is waterproof.

A little more care in cutting out gaskets from sheet packing will make a big saving in that commodity. It is time that more attention was paid to this important, if minor, detail.

When the engineer's requisitions are not honored in full it is time to get a new chief or a new man in the supply department. Trust a man or fire him.

Most men, when counting revolutions, count one too many by counting "one" when the cross-head starts down instead of when it just comes up to the top of the stroke. Begin the timing when the cross-head starts down and the counting when it first comes up.

Letters from Marine Engineers

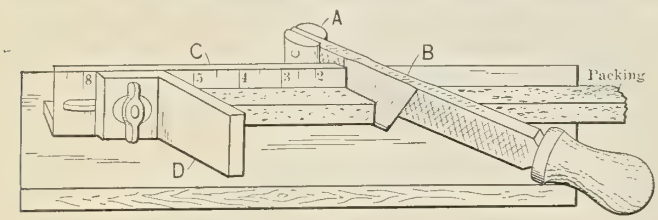
Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

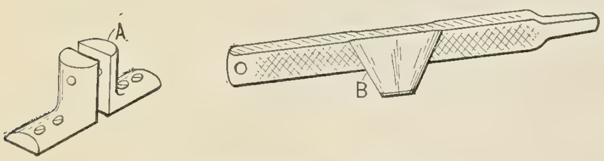
This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Rod Packing Cutter

A very useful device for cutting rod packings was devised and used by the writer, and it may be found worth while to others. There are so many piston and valve rods and stems, slip joints, etc., which are always calling for packing, and the use of this device will save a lot of packing and labor in cutting the rings to proper length with quickness and ease.

Like many other useful devices, it is a home-made product, and can be made quite easily by any engineer or mechanic from materials to be found on board ship, an old file, a piece of angle iron, a bit of flat stock, etc. The sketch clearly shows the tool.





Home-Made Packing Cutter

The cutter is made from a long, flat file, drawing down the knife section as shown in *B*. This cutter is held in the guide posts *A*, which are secured to the board at a 45-degree angle from the packing guide *C*, which is made from a piece of angle iron. A longitudinal slot is cut for the adjustment of the length gage *D*. This is made from a small piece of flat steel bent to 45 degrees. The scale on the angle iron is graduated to cut packings to fit rod diameters from one to eight inches. The leverage of the cutter does the trick excellently, and the writer would not be without the cutter now. Engineer.

Improvised Dutchman for Shaft Coupling

During a high-speed, force-draft run one of the blower fan shafts fractured close to the outboard coupling, as indicated in Fig. 1.

The shaft and coupling were removed and the broken stub end forced out of the coupling. The shaft was put in the ship's lathe, squared up and centered, and a new fit made for the coupling, as shown at *A*.

This shortened the length of the shaft 3 inches. The key way was cut and then the coupling was forced on and keyed to the new machined end. Next, six special long bolts with three nuts on each were made and used, as shown in Fig. 2. The shaft was put in place and the bolts put in and adjusted to give 3 inches distance between the inside faces of the couplings, using a 3-inch distance piece as a caliper.

Next the complete coupling was formed into a mold by a band of sheet iron and some putty, leaving a pouring gate and a riser at the top for excess metal. Then the space between the faces of the couplings was filled with molten babbitt covering the bolts and filling, as shown in Fig. 3. This gave a very good Dutchman or distance piece and a quick repair.

It should be said that there was not a piece of stock of right dimensions on board to make a new shaft or solid distance piece. We thought at first of using pieces of pipe slipped over the bolts in between the faces, but abandoned that scheme when we thought of the use of long, solid bolts.

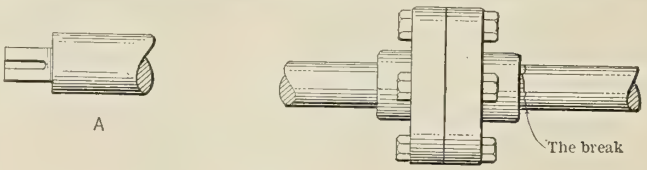


Fig. 1

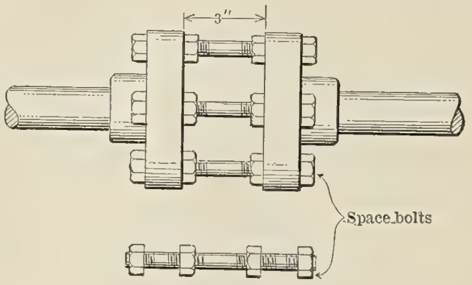


Fig. 2

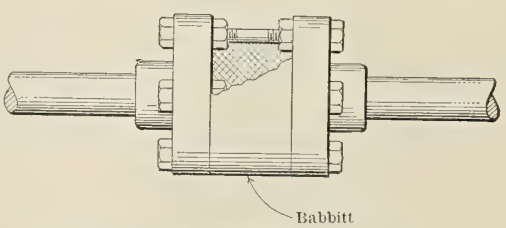


Fig. 3

Temporary Repair to Blower Fan Shaft

The repair was made at sea and we completed it four days out, and had no further trouble, as it stood up to full speed.

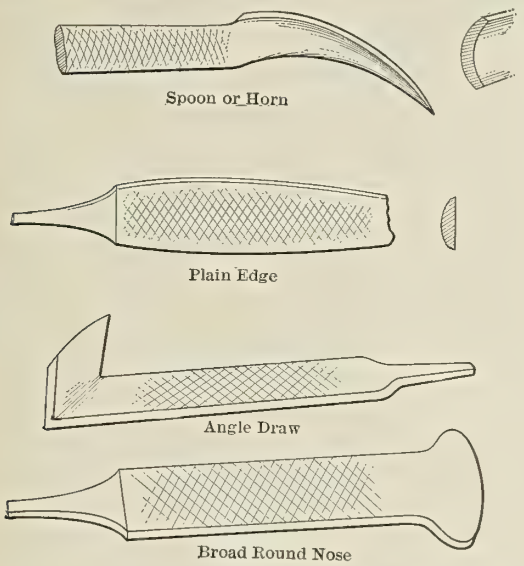
If any of the readers of Marine Engineering have the misfortune to meet with a broken shaft of small dimensions in a like way, the writer recommends giving this stunt a trial. Perhaps I should have mentioned that the outer circumference of the babbitt was peened dense with a ball peen hammer to fill solid, due to shrinkage in cooling. The

excess metal poured into the gate and riser of course aided the feeding for shrinkage, and but little peening was needed to make it absolutely tight.

Concord, N. H. C. H. WILLEY.

Scrapers

Don't throw away your old files. Use them for scrapers, as shown in the sketches. Every day steel is becoming scarcer, especially tool steel. You can do your bit to conserve the steel supply by making some of your tools from discarded, worn-out files, such as scribers, punches and



Scrapers Made from Old Files

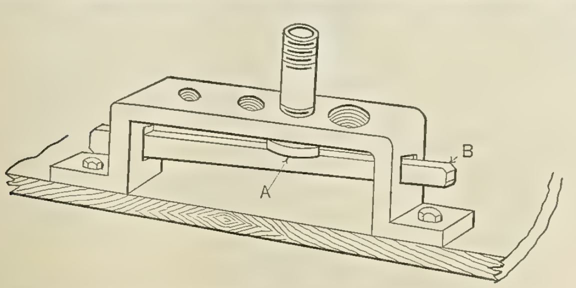
drifts, knives, chisels, packing tools, cotter pin extractors, and numerous other tools.

In working the files under the hammer, be sure to do so only when the heat is red. The moment the file cools to dark or gray there is danger of fracture if you continue to forge it. CONSERVATION.

Stud or Nipple Vise

All of us at some time or other have tried to improvise a means of holding a pipe nipple while we run down the threads, such as when making close nipples.

The device shown in the accompanying sketch has been used with a great deal of success and convenience, and may be found equally helpful to some of the other readers. It is easily constructed from a piece of ½- by 4-inch flat stock. The holes for nipples or studs are drilled and tapped through the top as shown. A washer or disk, *A*, is used between the bottom edge of the nipple and the edge of the wedge *B*. By driving in the wedge it forces the washer *A* against the lower edge of the nipple and binds

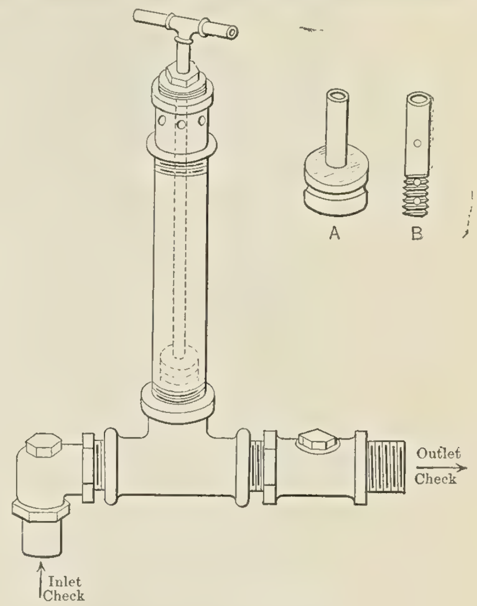


Construction of Vise for Holding Pipe Nipples While They Are Threaded

it securely. The sketch quite clearly shows its principle and construction. MACHINIST.

Handy Pump

No more useful article of equipment in the engineer department of a ship can be found than a hand pump of the type shown in the sketch. When the crank pits accumulate water or oil, when the thrust block oil well needs to be emptied, when the bilge pump strainer well needs to be dried and cleaned (like when you are going to red lead



Home-Made Hand Pump

the bilges, etc.), and numberless other places and tasks, this pump will be a labor and patience saver.

It can be made in almost any reasonable size from materials found on any ship, namely, some pipe fittings and a little babbitt metal. The plunger is made of babbitt metal, cast on the lower end of the pipe plunger rod, as shown in *A* and *B*. The end is threaded, and two small holes drilled to anchor the babbitt. The mold used to cast the plunger can easily be made of plaster of paris, or by chucking out a hard block of wood.

A water groove is best for this kind of plunger, which should be at least two inches deep. The babbitt is easily scraped to a nice fit in the pipe cylinder. When worn, the renewal is but a small task of re-casting. Drill small air outlets at the top and one or two in the rod, as indicated.

W.

The Removal of Propellers

One of the most troublesome of dry dock problems is the removal of the screw propeller from the tail shaft for examination and the relining of the stern tube. A case which several years ago came under the writer's notice was that of a bent tail shaft which would not draw through the stern tube. It is some time ago, because the remedy applied was truly herculanean.

A gang was set to work with ratchet braces drilling radial holes, some twenty 1¼-inch holes were drilled by hand round the shaft and each brace being kept continuously employed by reliefs. A suspended battering ram was then used to break off the projecting end of the shaft, while the tail shaft remained many a long day the object of interest to the visitor on the dock side.

Had the modern cutting torch been available it would have spared much expense, as something under an hour would have obviated the thirty-six hours' sheer toil required.

The president of the Institute of the Marine Engineers (London), Captain Richard Green, of Fletcher, Son & Fearnall, a well-known firm of ship repairers, told the following story in his recent presidential address: "One of the constant sources of trouble in the early days was the fit of propellers on the tail shaft, and most of us can remember the tussles that one had in getting a propeller started.

"One case always remains in my memory, on which we wrought three days and nights without being able to get a move out of the propeller. All the blades had been removed but every effort failed. Meanwhile, with continual heating, both shaft and boss had become very hot, also the superintendent engineer on the matter of delay.

"As a last desperate resort a 3/4-inch hole was bored through the shell of the boss under the seat of one of the blades and a length of ordinary gas pipe coupled up with the water main. The water was turned on and we awaited with expectation and some anxiety the result. We had not long to wait; for, with a report that shook the whole ship, the sudden contraction of the tail shaft shot the propeller hard against the stern post.

"The scared look on the face of the old superintendent as he rushed on deck from the cabin brought a hearty laugh, which relieved the tension of tired and irritated men.

"No damage resulted either to boss or tail shaft, which were refitted after examination and cleaning."

The primitive wedging with horseshoe collars behind the wheel and internal strutting to relieve the crank webs is a labor of great magnitude and the process does not always result in success, besides being clumsy. Failing this, heating the boss for release by expansion, unless there is some provision to release the contents of the vacant space inside the boss, is dangerous. If there be moisture present in very small quantity, the boss can be ruptured by the generation of steam, and accidents due to this cause are not unknown.

Any attempt to pull off the boss by mechanical means like screw or bolts and a strong back by the same principle that taper fits are dismantled in the usual machine shops is virtually impossible. The stern post and rudder, the limited propeller aperture, the fine character of the taper and its exposure to sea water, the limited area of the boss itself, all impede the application of such means.

There does exist a simple and positive device for the removal of propellers, taking only a few minutes in actual operation; it surprised the writer recently to find that the old style procedure was still in operation in some quarters and that the man in charge had never heard of the device. Thinking, therefore, that it is in the interest of marine engineers in general to give the device the publicity it deserves, the writer desires to draw attention to the Youngs' propeller starter. I hasten to add that I have no connection with the manufacturer, nor am I interested in any way other than the merit of the device.

The makers are Youngs of Birmingham, makers of lifting tackle and hydraulic jacks and other appliances. It consists essentially in a segmental cast steel frame in separate sections, each of which has a segmental hydraulic ram. The sections assemble into circular form behind the propeller boss, and by the use of suitable packing pieces 2, 3 or 4 segments can be operated. Each segment is interconnected by copper loop tubes which joint by unions, that the movement and pressure of the rams shall be simultaneous. A hydraulic test pump or boiler prover completes the outfit and two sizes are made, 300 tons and 450 tons.

The internal shaft is strutted in the usual manner, the device applied behind the boss and a few minutes' pumping serves to give separation after slacking back the main nut. So far as is known, no propeller has ever refused the gentle persuasion brought to bear and the prices charged for the device are by no means inordinate.

It is certain that the device is in use in literally hundreds of places, but, like many another first-class device, there are always a proportion of people to whom it would be a godsend who are ignorant of its merits.

A. L. Haas.

Temporary Pipe Patches

Marine engineers have to contend with a great many leaky pipes, and when a section of pipe springs a leak it is not always convenient at the time to cut out the bad section and replace with a new piece. Then, again, it may not be most economical, for the leak may be so located that to take out the bad piece would require uncoupling many sections of pipe to be able to get to it. On threaded pipe this works to its detriment, for seldom do the pipe joints re-make tightly without extra forcing into their couplings, etc. Again, when a leak does occur it generally is necessary to make temporary repairs to keep things going, and to this end the collection of temporary pipe patches taken from the writer's note book may aid some to make repairs easily.

With the great quantity of salt water service piping found on board ship there is bound to be ample requirements for one or more of these patches, for one can never tell when a section will be eaten through by corrosion. The writer has made it a point to make up several emergency patches for various sizes of piping, and those who

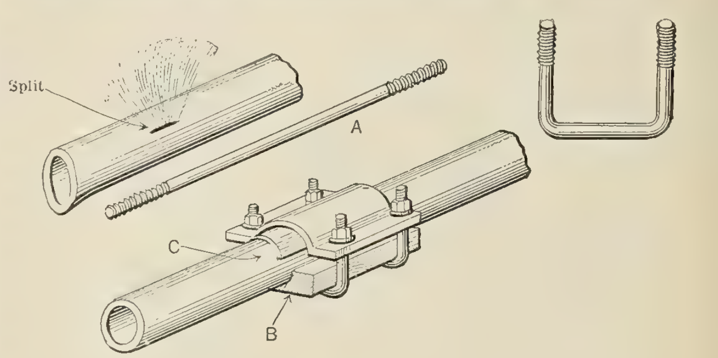


Fig. 1

are serving on board of an old vessel know fully the value of preparedness along these lines.

The U-bolt patch in Fig. 1 is very serviceable and easy to make. It consists of two lengths of round iron stock, shown at *A*. These are threaded at each end and formed into U-shape to comply with the required size. A block of hard wood is cut to V-shape, as at *B*, and a half-round metal patch is formed to the circumference of the pipe. A piece of rubber gasket is used under this at *C*.

The coupling patch shown in Fig. 2 is one that can be quickly made, when the troublesome leak is on small size pipe lines. One can generally find in the scrap pile or in the stores on board a piece of the same size pipe, or perhaps a larger size. By cutting a couple of pieces of this off and splitting as shown in Fig. 2 at *A*, then bending the ears back as indicated in the dotted lines and drilling a couple of bolt holes in the ears, the patch is then ready.

Wrap a piece of gasket around the leaky pipe and then bolt on the patch.

For small leaks on low pressure pipes the simple band clamp shown in Fig. 3 is easily and quickly made from a piece of band iron. This must be formed hot on the pipe and cooled, the bolt holes being first drilled.

Figs. 4-5 show what is perhaps a unique temporary

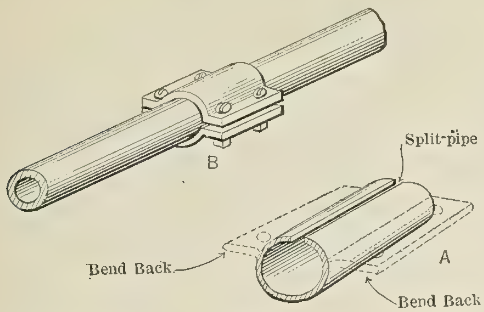


Fig. 2

patch made from blocks of wood, strong wire and some rubber gasket. These patches are adapted to large size pipes, such as condenser piping for emergency use until a better repair is possible by sweating on a copper patch or renewing the pipe.

For pin-hole leaks, the head of a common wood screw

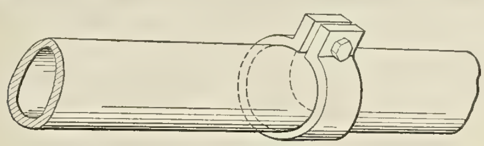


Fig. 3

cut off and used as shown in Fig. 6, with a bit of wire and gasket, is useful. The hole can be made to receive the screw by reaming out with the tang of a file.

Sometimes it is not possible to use any form of pipe clamps or bulky patches, due to the location of the pipe. When such a case is found, the sort of patch shown in Fig. 7 will be found very suitable and serviceable. The writer has used this method of making permanent repairs

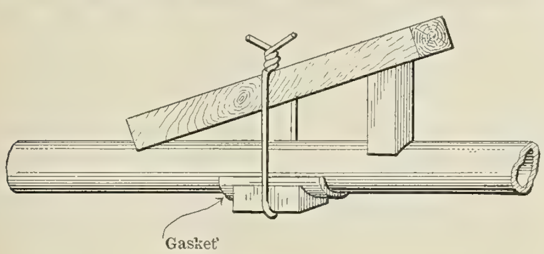


Fig. 4

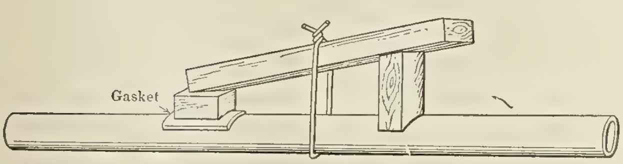


Fig. 5.—Temporary Pipe Patch

to several split pipes, for, when finished, shellacked over and painted, it does not present a bad appearance. The leaky or split pipe is wrapped with a piece of good gasket material, then with soft iron, brass or copper wire the gasket is bound tightly. The wire must be closely woven and the ends secured. Next a long, narrow strip of canvas is made and soaked in red lead. This is then wound on over the wire, making sure to overlap each layer and to continue on a little further than you wound the wire. After this is applied, take a roll of adhesive tape and start wrapping the pipe in the opposite direction, as shown, overlapping each layer. Make sure to bind all coverings very tightly and evenly. Shellac over the tape, and when possible paint it the color of the local piping.

The ring patch shown in Fig. 8 is a handy patch for small pipes. Cut off an annular section of a larger size pipe and drill and tap it for a set screw or bolt. Break the nearest joint or union and slip the ring on over the pipe. Work it along to the leaky place. Put a piece of gasket over the leak and inside the bottom of the ring, as

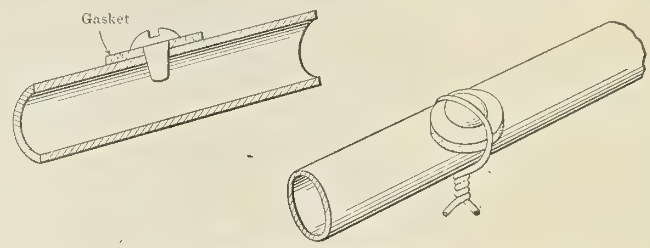


Fig. 6.—For Small Leak

indicated in the sketch. Place a protecting piece of metal under the point of the screw, set it up, and the patch is done.

The brazing at the flange joint on one section of the 14-inch main steam line sprung a leak on the writer's ship, and it continued to get worse in time, so much so that the whole interior of the compartment at the upper part would be all covered with moisture due to the condensed vapor adhering. Everything began to rust. We tried to calk the leak to lessen it, but it got worse. Now, it's no cinch to break down a section of 14-inch steam line with male and female joints. To repair it on board ship,

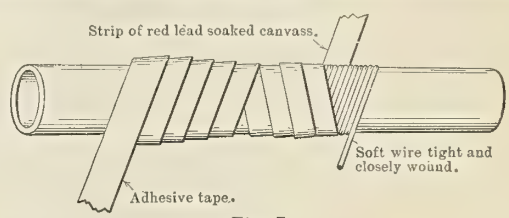


Fig. 7

and to do it with only a limited amount of time in a foreign port in these days of rush voyages, would have been worse. Some sort of a temporary repair had to be made, so we got to scheming, and the result was a packing clamp made in the ship's machine shop. A bar of 1¼-inch square stock was made into two half rings at the forge. The ends of these were lap-jointed, and then the ring was put in the lathe and bored to the diameter of the steam line 1/16-inch clearance, and one edge was faced conical. Two

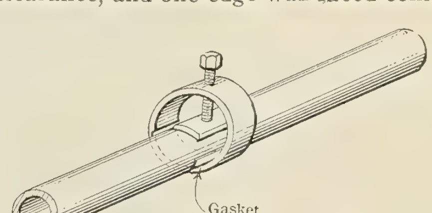


Fig. 8

views of the ring are shown in Fig. 9 at *C* and *D*. Four long, threaded bolts of the same diameter as those used in the joints were made, as at *A*, and four straps, as shown at *B*, the one end of the strap being bent over double to give bearing surface on the bolts. This completed the clamp.

A piece of spiral, high pressure packing was cut and

fitted to the diameter of the pipe, and then the two halves of the clamp were put on and bolted together with top screws. Four of the regular flange bolts were taken out (steam line dead), and the four special long bolts put in at 90-degree points. The packing was then put hard against the leak at the brazing and the ring drawn up against it by

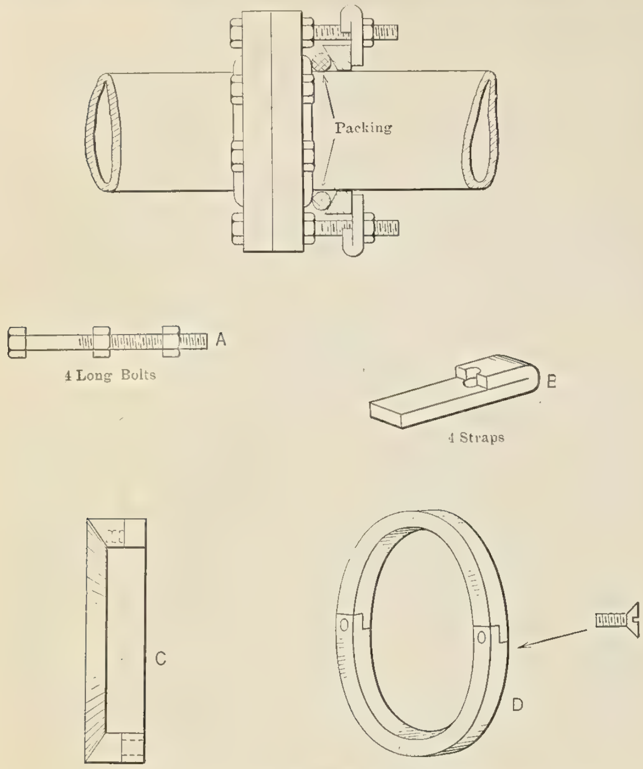


Fig. 9

the four straps, as shown in sectional view in Fig. 9. Steam was turned into the line and the packing again tightened. To our great pleasure, the leak was conquered.

Concord, N. H. C. H. Willey.

Indicator Test of Triple Expansion Marine Engine

This test was performed on the main propelling engine of the steamship *Mohawk*, of the Clyde Line Steamship Company, plying between New York City and Jacksonville, Fla., with Charleston, S. C., as an intermediate stop. The *Mohawk* is a combination freight and passenger steamer 380 feet in length, 48 feet extreme beam, with a gross tonnage of 4,623, and accommodations for 220 passengers. She was built by the Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., during 1907-08.

Steam is supplied by four Scotch boilers, 14½ feet in diameter, 11½ feet long, each having a heating surface of 8,500 square feet. These boilers have a safety valve which operates at 181 pounds gage pressure, but were tested when installed to 272 pounds per square inch hydrostatic pressure.

Forced draft is used, air being supplied by two Sturtevant fan blowers, which, with the assistance of a stack 76 feet high and 8 feet in diameter, gives an average draft of 1.3 inches of water.

These boilers are supplied with water from an open heater, which uses the condensate from the condenser, after same has been filtered. Any additional water which is added on account of unavoidable waste is drawn from a reserve supply taken from the bilges.

The water is heated in the open heater to an average temperature of 235 degrees F., a pressure of 14 to 18 pounds gage existing. The steam used for heating is that exhausted from the many auxiliaries used in connection with the plant. An ingenious scheme is employed in this respect, in that a valve is placed in the auxiliary exhaust, which permits steam above 18 pounds absolute to pass into the low pressure cylinder and thus work is derived from it.

The main engine is of the vertical, triple expansion, condensing type, having tail rods. The high, intermediate and low pressure cylinders are 27½ inches, 46 inches, 76 inches in diameter, respectively, with a common piston stroke of 42 inches. The cranks are set 120 degrees apart operating in this sequence, H.P., I.P., L.P., the steam from the low pressure cylinder being discharged into a surface condenser, which is built into the frame of the engine and through which sea water is circulated by means of a centrifugal pump.

The ratios of the volumes of the cylinders are as follows: High pressure, 1.00; intermediate pressure, 2.84, and low pressure, 7.78.

Single ported, balanced piston valves are fitted to the cylinders; one 12-inch valve for the high, two 12-inch valves for the intermediate and two 25-inch valves for the low pressure. The high pressure and intermediate pressure have 8-inch travels, while the low pressure has a 9-inch travel. All valves are controlled by standard Stephenson link motion. They take steam on inside edges.

The propeller is four-bladed, 14 feet in diameter, and 16.52 feet pitch, connected to the engine by a shaft 14¾ inches diameter and 70 feet long, made in four sections, each 17 feet 6¼ inches in length, supported by eight well-designed babbitt bearings, besides the thrust bearing.

In addition to the main engine, there were in the engine room two General Electric marine type electric generating units, the cylinder of each engine being 8 inches in diameter and 6-inch stroke, and coupled direct to a D. C. generator, developing 15 kilowatts at a voltage of 110. There was also a two-cylinder, cross coupled, horizontal engine, 6 inches by 8 inches, driving the steering gear.

There were also two fan blowers driven by engines 5 inches in diameter, 4-inch stroke.

The surface condenser contained 4,799 square feet of cooling surface, and was supplied by cooling water from a centrifugal pump, driven by a separate engine. The wet vacuum pump connected to the condenser was driven by a walking-beam from the intermediate pressure crosshead.

Three feed pumps, one fire and one sanitary pump and one ammonia compression refrigerating machine concluded the rest of the engine-room equipment.

The test was made during a voyage between the ports of New York City and Jacksonville, Fla., and return. Indicator cards were taken every half hour during each test. Four tests were made during the voyage.

The average steam consumption, as given by the pump displacement calculations and the indicator cards, is 11.9 pounds of steam per indicated horsepower per hour. This steam was supplied at an average boiler pressure of 175 pounds per square inch gage and with an average quality of 95 percent. The discharge pressure averages 2 pounds absolute. The actual thermal efficiency of the engine at these conditions is as follows:

Steam 175 pounds gage, 95 percent quality, total heat above 32 degrees F. = 1,155 B. T. U.

Consumption pounds per indicated horsepower per hour = 11.9.

Temperature of feed water, degrees F. = 235 F.

Heat per pound in feed water, 235-32, = 203 B. T. U.

Heat actually given to steam per pound, 1,155-203, = 952 B. T. U.

One horsepower in foot-pounds per minute = 33,000.

One horsepower uses 952 × 11.9 B. T. U. per hour = 113,200 B. T. U.

$$\text{One horsepower hour} = \frac{33{,}000 \times 60}{778} \text{ B. T. U. per hour} = 2{,}545 \text{ B. T. U.}$$

$$\text{Actual thermal efficiency at 175 pounds gage} = \frac{2{,}545}{113{,}200} \times 100 = 22.4 \text{ percent.}$$

The ideal maximum efficiency obtainable with the Carnot cycle was 29.4 percent. The actual thermal efficiency was 22.4 percent. This speaks well for the performance of the engine, since it is giving 22.4 percent efficiency out of a possible 29.4 percent.

The steam required to heat the feed water was worked out and it was found that the auxiliaries are supplying enough to give a feed water temperature of 235 degrees F., leaving no room for improvement in this respect.

Conclusions

It is very interesting to note that the indicated horsepower as computed six years ago is very nearly the same as was determined during this test, the difference being only a few horsepower. This tends to show that the engine is working under nearly the same conditions and is putting out the same power it did at that time. This also shows that there has been very little wear and tear, and no more losses are occurring than did occur at that time.

In connection with the steam consumption, no accurate determination of this was made. The reason for this was that there was no method by which the steam could be measured during this short test, because of the limited time of preparation. The pump from the condenser pumped out the air as well as the condensate, therefore the consumption of steam could not be calculated by the capacity of this pump. From the condenser the mixture of air and water was carried to the filter box, which could not easily be calibrated.

The feed pump delivering water to the boiler supplied enough for engine and auxiliaries, therefore a determination of the engine consumption could not be made. An approximation was therefore made by taking 10 percent of the total steam as being used by the auxiliaries. The total consumption was computed from the feed pump by multiplying the total displacement of the pump per stroke by the strokes per hour, and the cubic feet determined were then converted to pounds per hour.

The coal consumption, another important item in any test, could not be accurately determined because there was no way on shipboard whereby the coal used during a test could be determined. The total consumption during the trip was ascertained, but this was of little use, as coal was used during the stops at Charleston and Jacksonville, which ought not to be included in the consumption during the run, but which could not be separated from the total. For this reason no computation of coal consumption was made.

The mechanical efficiency could not be determined because the developed horsepower could not be found, because the actual thrust was not obtainable. In determining the thrust, the frictional losses were neglected. In other words, the mechanical efficiency was neglected. Of course, the actual thrust could be approximated by finding the resistance offered by the water to the passage of the boat, but this would not take into account any currents, and would, moreover, be a very complicated calculation.

As far as accuracy goes, the test gave a very good idea of the indicated horsepower of the ship.

New York. A. C. De Lorme.

TABLE I—STEAM CONSUMPTION FROM CARDS

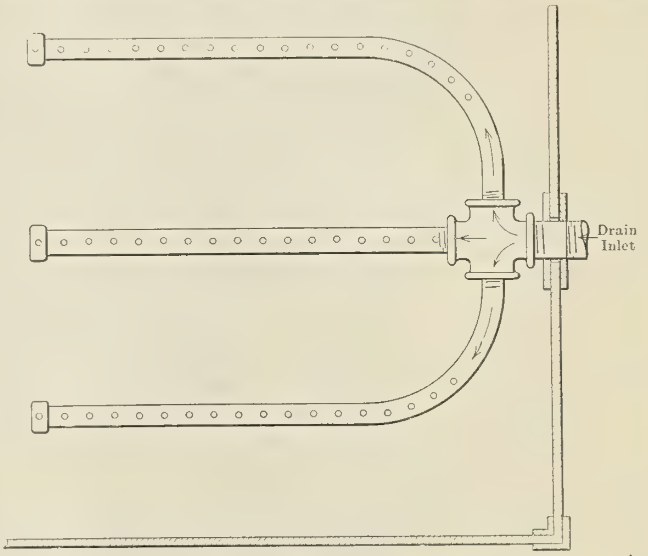
Run No.	R.P.M.	M.E.P.	I.H.P.	Lbs. Steam. Per Rev.	Per Hr.	Per I.H.P. Hr.
1	103.20	92.37	3913	7.24	44912	11.50
2	103.60	93.48	3956	7.66	47726	12.05
3	100.82	88.10	3774	7.01	42020	11.63
4	102.15	83.10	3869	6.57	.....	10.42
					Average	11.40

TABLE II.—STEAM CONSUMPTION BY CALCULATION FROM FEED PUMP DATA

Run No.	Strokes Per Hr.	Piston Displ. H. E.	Piston Displ. C. E.	Cu. Ft. Pumped Per Hr.	Temp. Water.	Lbs. Pumped Per Hr.	90% Used By Main Engine.	Average I. H. P. For Run.	Lbs. Per I. H. P. Hr.
1	3756	.2632	.2265	920	235	54593.0	49133.5	3913	12.5
2	3720	.2632	.2265	912	235	54120.0	48652.0	3956	12.3
3	3550	.2632	.2265	868	235	51516.0	46452.0	3774	12.3
4	3727	.2632	.2265	912	235	54201.0	48750.0	3868	12.6

Feed Tank Drain Silencer

The hot returns going into our feed tank from the drain lines always caused a hammering and rattling, clattering noise, due to the inrush of hot water and steam into the large body of cooler and dormant water. The distributing pipe of this troublesome arrangement was nothing more than a straight lead of 4-inch pipe drilled full of holes. The writer felt that if the drains were better distributed over a larger area less noise would be had and better results obtained.



Arrangement of Perforated Piping in Feed Tank

The scheme of piping shown in the sketch was used, reducing the size of the pipe to 2½ inches and drilling sufficient ¼-inch holes to give full volume outlet to each pipe. The chief was highly pleased, for the water was heated to a higher degree, which put less work on the feed water, enabling the reducing of the back pressure of the exhaust line, which we all know means economy.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number if from examination for grade of chief, and by a dagger (†) if from examination for other grades.

Projected Length of Normal Thickness of Wooden Ship's Planking

Q. (952).—(a) Will you please show a practical method of obtaining the projected length measured along a transverse section of the ship, of the normal thickness of a wooden ship's planking, i. e., the deduction at each section line for the thickness of a ship's planking? (b) The theory involved would also be highly appreciated as I think descriptive geometry is one thing and its practical application very often entirely another.

A. (952).—The following method is used in some of the best yards in Great Britain; it is sufficiently accurate, and will be found, I think, to be one of the fastest and simplest methods in use. After the molded lines (to the outside

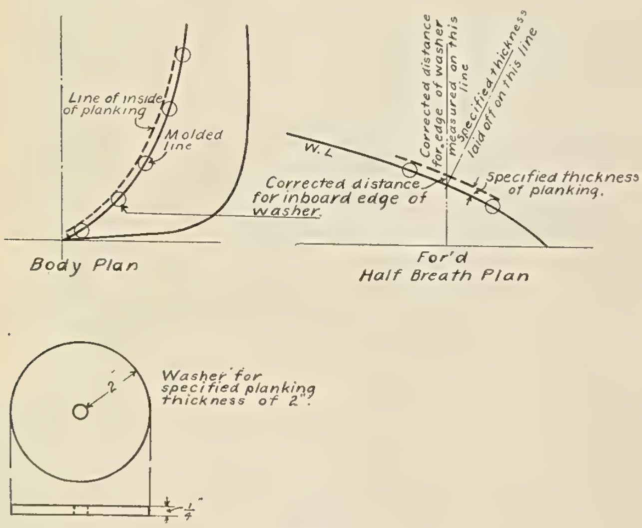


Fig. 1

of planking) have been laid down on the mold loft floor, washers are made of ¼- or 3/16-inch plate, with a difference of radii measured from the edge of the hole to the outer edge, equal to the thickness of the planking specified. These washers are slipped over pins driven into the floor on the molded lines of the body plan and then the batten is run tangent to the washers. This gives the transverse section taken to the inside of the planking or the outside of the frame, with sufficient accuracy for the frames lying amidships where the waterlines are parallel to the center line, or nearly so. Forward and aft, where the waterlines have an appreciable angle with the center line, the washers on the body plan sections must be adjusted inboard to correct for it. This corrected distance is obtained by laying off in the half breadth plan normal to the waterline the specified planking thickness and measuring the equivalent thickness parallel to the cross-section plane. The inboard edge of the washer on the body plan station is then set this distance from the molded line. (See Fig. 1.)

Method of Finding Harpin and Ribband Lengths to Mark Frame Spacing

Q. (953). Please give the best method of finding harpin and ribband lengths so as to mark on them the correct frame spacing before erecting.

A. (953).—After the ribband is drawn in the body plan obtain its projection in the sheer plan. Pin a flexible batten on it and mark the stations; let the batten be straightened into a horizontal line, keeping the F. P. in

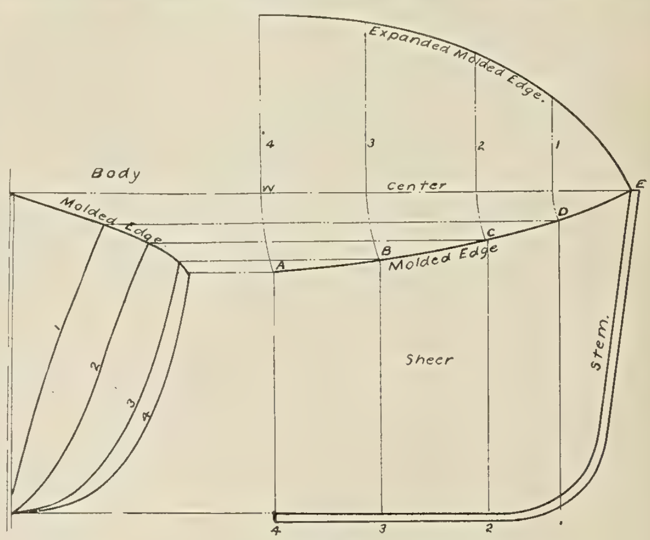


Fig. 2

agreement. This gives the new station positions for the developed or flattened sheer condition. On these expanded stations lay off the half breadths measured from the body plan (See Fig. 2). Watson's "Manual on Laying Off" (Longmans, Green & Co., N. Y.) devotes a chapter to ribbands and harpins, which gives complete information. The above sketch is modified from that.

Propulsion Problem

Q. (958).—Will you kindly work out and explain the following: If a ship makes 18 knots on 100 revolutions per minute and 25 percent slip, what will she make with 120 revolutions per minute and 20 percent slip?

A. (958).—Speed in knots is equal to the product of one minus the apparent slip, the pitch (in feet) and the revolutions per minute, the whole divided by 101.3, which, expressed as an equation, is as follows:

$$V = \frac{(1 - S)\, P \times R}{101.3}$$

For the first case $V_1 = 0.75 \times P \times 100 = 75\,P$
For the second case $V_2 = 0.80 \times P \times 120 = 96\,P$

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* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

The two conditions are not compatible, however, for a given hull and the same propeller as the apparent slip increases with increasing revolutions per minute or speed.

Difference Between Angle of Advance and Angle of Lead

Q. (955).—Please explain the difference betwen angle of advance and angle of lead.

A. (955).—The difference between angle of advance and angle of lead may be understood from a study of their definitions.

The angular distance through which the eccentric is moved in order to shift the valve from its mid-position to that which it should occupy at the beginning of the stroke is called the *angular advance* of the eccentric.

The angular distance between the positions of the crank at the time of admission by the valve and when the piston is on the dead-point is called the *angle of lead.*

From the definitions it may be seen that angle of lead refers to the crank, and angle of advance, to the eccentric.

Design of Tugboat

Q. (954).—(a) Please give an intelligent method of designing a tug boat. I know that their average speed is from 15 to 16 miles, slip 20 percent, with a good tow approximately 50 percent slip, and with a ship or something that cannot move the slip is unity. But I would like to have discussed a method of approaching the problem from another angle, —i. e., having given a tow of 15 or 16 barges—110 feet by 30 feet by 7 feet, with a 15 foot rake ending 3 feet down from deck, and loaded to rake edge. Which is the best method of going at the design in order to get just sufficient power to drive the tow 3 miles per hour against a 3 mile current?

(b) Also an intelligent outline of the best form of keeping data for such a problem in order to design a hull which will just envelop the required machinery without building too much tug—i. e., the best method of proportioning the dimensions of hull after arriving at the proper indicated horsepower to do the work of towing.

(c) Can any law of comparison be applied to such a problem with barges to tow? Such problems will certainly come up in connection with our inland water ways and rivers.

A. (954).—(a) A detailed answer to your question is beyond the scope of this column, but a brief resumé of the steps and the order in which they should be taken is given below:

First.—Estimate the curve of resistance on speed for the tow.

Second.—Do the same for a tug of assumed dimensions approximately sufficient for the work.

Third.—Construct the final curve of total resistance on speed by adding 2 to 3.

Fourth.—The resistances at each speed multiplied by that speed will then give the curve of effective horsepower on speed for the tug and her tow.

Indicated horsepower $\times$ efficiency of engine $\times$ efficiency of propeller $\times$ hull efficiency $=$ effective horsepower, and conversely effective horsepower $\div$ efficiency engine $\div$ efficiency propeller $\div$ efficiency hull $=$ indicated horsepower.

Fifth.—Estimate each of the efficiencies noted for the 6-mile condition and divide the effective horsepower at 6 miles (3 miles speed + 3 miles current) by the continued product of these three efficiencies to get the estimated indicated horsepower.

It is desirable to do this for other speeds above and below and construct a piece of the indicated horsepower on speed curve.

Sixth.—Select the indicated horsepower found necessary and estimate the weight of propelling machinery.

Seventh.—Estimate the dimensions of a hull just sufficient to carry this indicated horsepower with its fuel, etc.

Eighth.—The dimensions thus obtained will probably not be those at first estimated under No. 2, but should not be far different. Now repeat the procedure outlined above with the new hull dimensions, thus obtaining the final estimate.

For excellent data on the resistance of barges under tow efficiencies, machinery weights, etc., see the following reference: *Experimental Towboats,* U. S. House of Representatives, 63d Congress, Document 857—Report on Two Experimental Towboats with a Complement of Suitable Barges . . . . for Towing and Delivering along the Mississippi River and Its Tributaries.

Also see Marine Engineering, February, 1917.

(c) The laws of comparison hold for conditions of similitude and are one of the best helps in designing. The first reference cited above gives a table of dimensional formulæ (P. 16), showing according to what function of speed and displacement the various characteristics vary.

Horsepower of Boiler

Q. (957).—Here is a case hard to beat. I am in charge of a 150-horsepower straight line engine. Steam is furnished by a single furnace dryback marine boiler—no dome; stack is about 3 feet wide and 65 feet high. There are seventy-two 2½-inch tubes, 12 feet long. The furnace is 40 inches by 10 feet of 7/16-inch metal of the Morrison style. At a rough guess what horsepower would you say it is?

A. (957).—In stationary practice it is customary to rate a boiler on the basis of 10 square feet of heating surface = 1 horsepower. This method of rating a boiler is *arbitrary,* has been adopted simply as a *matter of convenience,* and assumes that 10 square feet of heating surface under normal operation are capable of evaporating 34.5 pounds of water per hour from and at 212 degrees F.

For your case the heating surface is

$$72 \times 12 \times \frac{2.5 \times \pi}{12} + \tfrac{1}{2} \times 40 \times \pi\ 10 = 565 + 628 = 1{,}193$$

square feet, approximately.

According to the above custom of rating, this would be sold for a boiler of $1{,}193 \div 10 = 119$ nominal boiler horsepower. To correct this estimate for the feed temperature of 50 degrees F. instead of 212 degrees, assumed, the factor of evaporation would be about 1.20, giving a rough estimate of the horsepower in accordance with the A. S. M. E. rule (34.5 pounds water from and at 212 degrees) of $119 \div 1.20 = 100$ boiler horsepower, approximately.

Pressure and Heat Engines

Q. (960).—Will you kindly explain just what is meant by pressure and heat engines, as referred to in "Practical Marine Engineering," by Rear Admiral C. W. Dyson, in Section 29, third paragraph?

A. (960).—The distinction is not a good one, for both are heat engines in the commonly accepted meaning of that term; i. e., an engine which transforms heat energy into work. The heat energy having been given to the steam is tranformed into work in the first case via an expansion in which the steam continually presses against a piston; but in the second case the expansion simply produces velocity in the jet of steam with its attendant kinetic energy, which, via the rotor, is transformed into work. Practically all of our prime movers of to-day, except electric ones, are heat engines.

Procedure When High-Pressure Crank Pin Breaks

Q. (961).—If the high-pressure crank pin of a triple-expansion engine broke at sea, how would you proceed?

A. (961).—If the necessary spare parts are not available stop the engine immediately, remove broken parts and connecting rod. Secure piston at the bottom of its stroke by clamping slipper to the guides; this step is not necessary unless the bottom steam port is open when the piston is resting on the bottom cylinder head. By-pass steam to the intermediate and then operate engine at reduced pressure by throttling or allow steam to pass through high pressure cylinder to the intermediate cylinder.

CONCRETE SHIP BUILDING IN SPAIN

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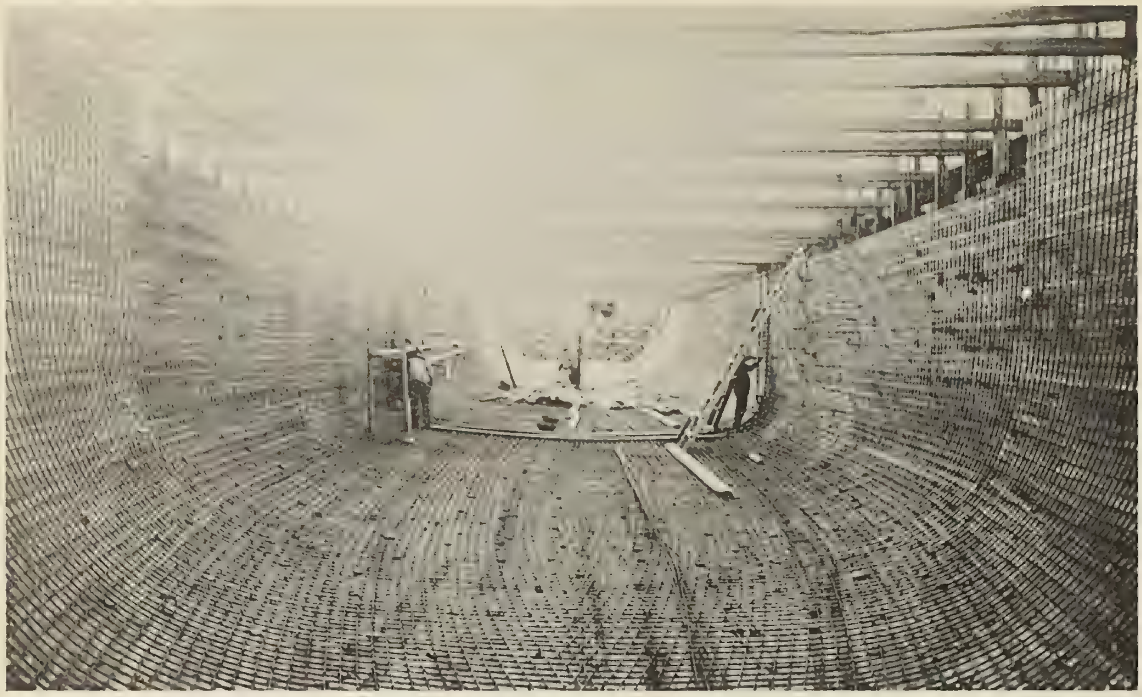
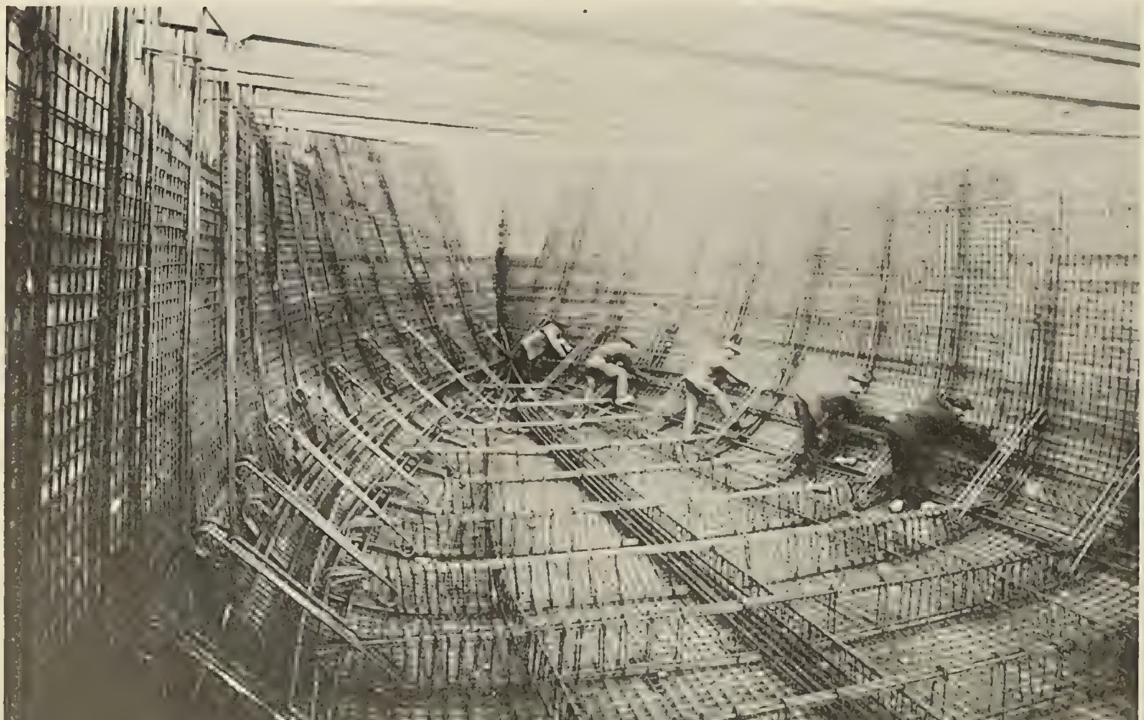


Concrete Ship Building by Works and Pavements, Barcelona, Spain



Laying the Bilge Reinforcement

Shipbuilding and General Marine News

**Contracts for New Ships—Shipyard Improvements—
Engineering Projects—Improved Appliances—Personal Items**

SHIPPING SUNK DURING THE WAR TOTALS 11,827,527 TONS

Tonnage Built Amounts to 6,606,275 Tons

Figures Issued by British Admiralty

Three statements compiled by the British Admiralty were recently published by the British Embassy in Washington giving shipping losses by enemy action and marine risk, mercantile shipbuilding output and enemy vessels captured and brought into service from the beginning of the war up to January 1, 1918.

These statements show that 11,827,527 gross tons of shipping have been sunk, of which 7,079,492 gross tons belonged to the United Kingdom and 4,748,080 gross tons to other countries. Against these losses 6,606,275 gross tons of shipping have been built, 3,031,555 gross tons by the United Kingdom and 3,574,720 gross tons by other countries. Added to this 2,589,000 gross tons of enemy vessels were captured and brought into service.

Decrease of 2,500,000 Tons

According to recent statements made before the House of Commons by Sir Eric Campbell Geddes, First Lord of the Admiralty, the world's tonnage, exclusive of enemy ships, had fallen 2,500,000 tons from the beginning of the war to the end of 1917. The total allied and neutral tonnage is now 42,000,000 tons, he said, and the tonnage sunk in the last twelve months was 6,000,000. During the last quarter of 1917 the Allies were averaging within 100,000 tons monthly of making their losses good, and were then replacing 75 percent of their lost tonnage.

At the present time 47 shipyards in Great Britain, with 209 berths, are engaged on ocean-going merchant vessels, and the output in repair work had increased in February, 1918, as compared with August, 1917, by 80 percent.

Bethlehem Steel Corporation's Part in the Shipbuilding Programme

According to a statement made by C. M. Schwab, chairman of the board of directors of the Bethlehem Steel Corporation, in the annual report to the shareholders, there were on the books of the Bethlehem Steel Corporation, at the close of 1917, orders for naval and merchant vessels to an aggregate value of $273,000,000. Mr. Schwab predicted that deliveries of these vessels would probably be completed on schedule time.

Other Government and private contracts brought the total of unfilled orders on December 31 up to $453,808,759. As an indication of how completely the capacities of the Bethlehem Steel plants are being utilized, the contracts on hand on January 1, 1914, prior to the outbreak of the European war, aggregated only about 5 percent of this total.

Shipbuilding for Beginners

Volunteer shipyard workers can obtain from the United States Shipping Board Emergency Fleet Corporation, Washington, D. C., for the asking, a copy of a book entitled "Shipbuilding for Beginners," prepared by Assistant Naval Constructor A. W. Carmichael, U. S. N., which tells the man in the shipyard what he is to do, why he is to do it and how he should do it.

This little volume will be found a valuable asset in every shipyard in the country where beginners are taking up the unfamiliar task of building ships.

Annual Meeting of Institution of Naval Architects

At the annual meeting of the Institution of Naval Architects, held in London, March 20 and 21, the following papers were read:

"Standard Cargo Ships." By Sir George Carter, K. B. E.

"The Most Suitable Sizes and Speeds for General Cargo Steamers." By John Anderson.

"Problems of the Future in the Design and Construction of Merchant Ships." By W. S. Abell.

"On the Value of Research Work in Marine Engineering." By A. E. Seaton.

"The Effect of Longitudinal Motion on a Ship and Its Statical Transverse Stability." By G. S. Baker, O. B. E., and Miss E. M. Keary.

"The Iron Carbide Equilibrium Diagram and Its Practical Usefulness. By Prof. H. C. H. Carpenter.

"Stress Distribution in Bolts and Nuts." By C. E. Stromeyer.

"A Preliminary Study of the Possibilities of Reinforced Concrete as a Material for Ship Construction." By Major Morris Denny.

"Reinforced Concrete Ships." By Walter Pollock.

"Design and Construction of the First Self-Propelled Reinforced Concrete Seagoing Cargo Steamer Built in Great Britain." By T. G. Owens.

"An Investigation of the Shearing Force and Bending Moment Acting on the Structure of a Ship, Including Dynamic Effects." By A. M. Robb, B. S. C.

"Air Supply to Boiler Rooms." By R. W. Allen, C. B. E.

NAVAL APPROPRIATION BILL CARRIES A TOTAL OF $1,327,600,000

Construction of Destroyers and Submarine Chasers Rapidly Progressing

Three-Year Naval Programme to Be Resumed

The annual naval appropriation bill recently reported to Congress calls for an appropriation larger by over $800,000,000 than any prior naval bill, carrying in round numbers $1,327,600,000. This sum, according to a statement of the Secretary of the Navy, together with last year's bill and the supplemental appropriations carried in the two deficiency bills of the preceding session, make almost $3,000,000,000 provided for the navy in a little more than twelve months. The total expenditures of the navy from 1794 to 1916, inclusive, a period of 122 years, only exceeded this sum by three hundred and sixty odd million dollars.

The bill provides the money necessary to carry forward the three-year programme of battleships, battle cruisers and other types of ships already authorized. It also provides another emergency fund of $100,000,000 which may be used for the construction of destroyers and other small craft, which are the present most pressing need in the fight against the submarine menace.

The work of building destroyers has progressed rapidly, and in addition to the large destroyers contracts have been let for a large fleet of specially-designed 200-foot submarine chasers. A large number of these smaller destroyers will be built at the Ford plant in Detroit and at a new Ford plant on the Newark meadows, New Jersey.

In accordance with the recommendations of the Secretary of the Navy, this bill increases the enlisted strength of the navy for the period of the war from 87,000 to 180,000 men, irrespective of apprentice seamen, hospital corps, men of the aviation branch and men in training in trade schools, and also temporarily increases the enlisted strength of the marine corps from 30,000 to 50,000 men.

Nearly $200,000,000 is provided for aviation purposes. For the expansion of existing navy yards and naval stations and to equip a number of yards for the construction of capital ships, torpedo boat destroyers, submarines and auxiliaries, the bill carries $12,000,000 for the Bureau of Yards and Docks. For ordnance purposes the bill provides the sum of $167,000,000. This, with the sums and authorizations in the recent urgent deficiency bill, makes a credit of over $600,000,000 for navy ordnance alone in the space of twelve months.

HOW BUSINESS EXECUTIVES CAN HELP THE SHIPBUILDERS

Organized Efforts Will Solve Local Problems

The key to the whole ship question is that the business men of the country must know the need for ships; and that they be educated to the idea of ships; that they be organized to force and further the building of ships; and that they become, when so organized, the medium through which things will get done in their several communities, is the recent statement made by Edward A. Filene, chairman of the War Shipping Committee of the United States Chamber of Commerce.

There can be no question of their willingness to help. The most insistent inquiry that comes to Washington is "How can I help? What can I do? Show me the way!"

The answer comes from the War Shipping Committee of the Chamber of Commerce of the United States. It calls on every business organization in the country—particularly the organizations in shipbuilding communities—to organize for the carrying out of a well-defined programme for local action.

Practical Aid

It calls on them to sit in with the shipbuilders once a week, and actually go over their problems, to find out just how they can help. It is not at all the same thing as making a general blanket offer to help, and then sitting back to await the call. That has been tried, and it has failed. The need is for active and continued counsel through which the business men of the community seek, without officious interference, to relieve the shipbuilder of as many of his nontechnical problems as he needs to be relieved of.

For example, the traffic expert of a business association can be of great assistance to shipbuilders in getting materials for their work if he be free to give such help and makes it his first duty to do so.

Carrying Workmen to the Shipyards

Of capital importance also is the question of carrying workmen to and from their work. The car lines in many communities are unable to meet the extra load which the influx of thousands of workers has put upon them. Some communities have had to solve the problem by changing the local business schedule by opening stores and offices a half hour later in order to have two peak loads, and so give the workmen a rush hour of their own each morning.

It may even mean that the local business organization must requisition the services of owners of private automobiles to carry men to and from their work. Think of the opportunity there for the shipbuilding community whose business men are organized for action! Think of what it would mean if this were regularly done, and if the workmen of the plant saw daily a string of hundreds of automobiles, from flivvers to the finest made, waiting to carry them, at considerable sacrifice and inconvenience, so that they might do their work for the nation to the best advantage! Can one imagine such workmen striking, or delaying ships, or refusing to adjust their differences with their employers through established boards of arbitration?

Housing Problem

The housing problem is one of the most serious we have to face. Cantonments and houses will be built. The Government has just appropriated $50,000,000 for that purpose. But they will not be ready in less than six months, and we cannot wait. Here, again, the organized business men of the community must solve the local problem; and they must see to it that the citizens of their community, regardless of questions of personal convenience, shall take these workmen into their private homes till other accommodations are ready. Care could be taken, of course, to make careful choice of the right man for the right home. Indiscriminate distribution of men through all classes of homes would be unnecessary. But the fact remains that the thing must be done, whether or no, and done at once.

"Every shipbuilding community should adopt a definite policy of recognition in its relations with the ship workers. I have in mind several incidents that will serve to leave a concrete impression of this fact in the reader's mind," said Mr. Filene.

"On a recent trip to a shipbuilding city in the South I saw a new ship that had been lying idle at a certain Gulf port because it had no anchor chains. The owner could not get them, though he had sent frantic appeals to Washington. I asked certain business men there if they could not have gotten those chains if they had undertaken it in behalf of that shipowner. They said they believed they could have put it through; and they said they would make the attempt at once. The notion of doing such a thing simply had not occurred to them.

"Here is a second example. In another city there was a grade crossing where freight trains blocked the approach to a shipbuilding plant. In consequence the workers were delayed in stormy or fair weather every morning and evening—sometimes as much as twenty minutes. The Chamber of Commerce, which had organized to help the local shipbuilders, took hold of the difficulty and had a bridge over that crossing in record time.

"In still another city a delay of weeks in the installation of electric power necessary for building ships was settled within three hours after the local Chamber of Commerce found out from the shipbuilders how they had been delayed.

"So much for the vital facts. They all point to one conclusion that cannot be understood too clearly—helping to build more ships is the most important war job at this time. The man or organization that successfully helps in this is doing a job which at this time is more important than that of the man with the gun."

Fencing and Lighting of Shipyards Ordered

An order sent to the district officers and supervisors by the vice-president and general manager, March 4, directs that proper provision be made for fencing and lighting of plants building ships for the Emergency Fleet Corporation.

BUILDERS OF WOODEN SHIPS URGED TO CO-OPERATE TO SPEED PRODUCTION

Frequent Meetings of Shipbuilders in Each District Suggested

James O. Heyworth, manager of the division of wood ship construction of the Emergency Fleet Corporation, issued a circular letter last night to all wood shipbuilders, as follows:

From personal inspection of yards, and from the reports of our traveling engineers, it is very evident that the methods of construction, elasticity of plants and equipment, and storage equipment and facilities are different in the different yards.

Some yards can work 300 to 400 men per ship at the time when the peak of construction of the ship is ready for them; other yards can work rarely more than 160 to 200 men per ship; even some of the old shipbuilders believe 100 to 125 men per ship is the limit for good construction.

Can Rely on Drawings

It must be remembered that in the Ferris standard type the plans are so accurate that much of the woodwork can be done with safety by sawing to the exact dimensions. For your information, there are yards where the old shipbuilder was doubtful whether he dared saw to the exact size, leaving from 1 to 3 inches that could be hand reduced after the timber was in place, taking this precaution to be sure that the alinement of the ship would come out right. Experience shows that the plans and drawings can be relied upon.

We have records of yards where they have put as high as 500 men on a ship to advantage. In one yard this has recently caught up previous delay by over two months. We have numerous yards where 300 to 400 men are worked to advantage on one ship. Other shipbuilders that I have personally talked to were fearful of either economic, or, from the production standpoint, that over 150 men per ship could be worked.

This wide variation in conception of the possibilities in construction can be very quickly remedied, as is being done in many yards to-day, and all future production materially increased if the following suggestion is carried out:

The shipbuilders in each district should form an association and meet at least once in every two weeks; remember that a week from now is equal to one month in ordinary times. The district supervisor should meet with this association; the meeting should be formal and carried on in a business-like manner, straight to the point, viz.: To illustrate by photographs and drawings, or papers, or brief talks, the advantages certain yards are obtaining by their methods and equipment and general handling of construction. The minutes of these meetings should be immediately put in proper form and distributed among the shipbuilders of the district, as well as a copy to the home office.

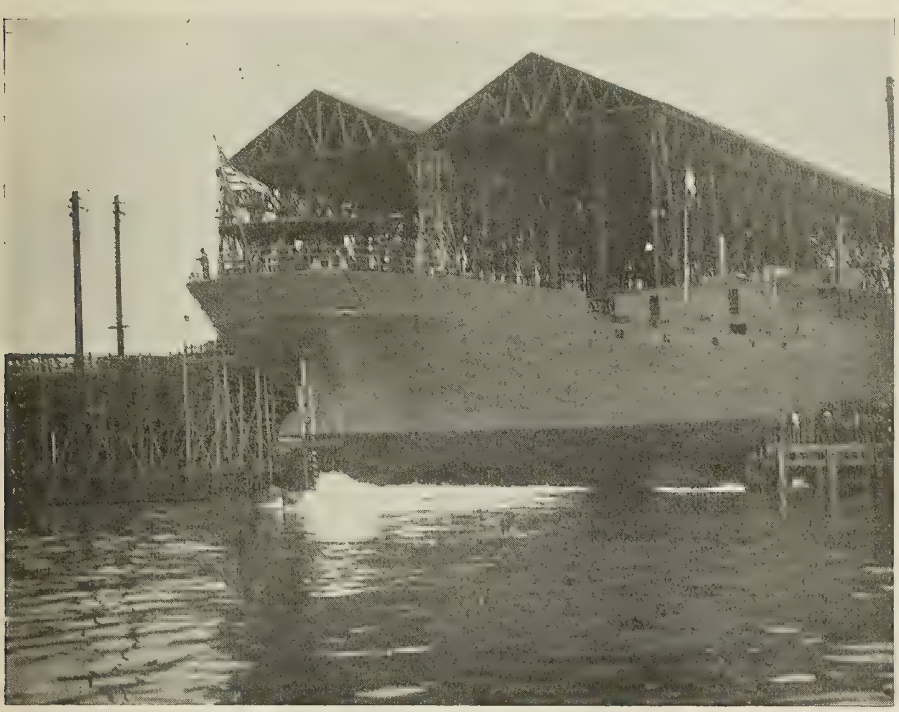
I shall be very glad to receive your comments, but the Emergency Fleet Corporation will be more interested to know

that some such plan of action has been adopted and put into working effect.

Must Speed Up Production

This is no time to work on the old basis for wood ship construction. The country needs ships more than anything else. We must have them. Production must be speeded up.

It is logical that a general comparison can be made where so many yards are at work, and it is also logical that many of the yards are being operated along extended over a period of four years, and the fruition will come at a time when the shipbuilding features are of particular general interest. Mayor Behrman, of New Orleans, already has conferred with Chairman Hurley, of the United States Shipping Board, with the object of making the best use of these facilities. He is convinced that the city would be lacking in its duty to the Government if it did not create shipbuilding facilities by turning its favorable topography to immediate account. The lock, basin and canal will connect the Mississippi River with Lake Pontchartrain, which is a navigable arm of the Gulf of Mexico, six miles away, and the enterprise, as a whole, is expected to furnish ideal terminal facilities.



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Launch of the 8,800-Ton Steel Steamship *Ossineke* at Skinner & Eddy Yard—the Second Vessel to Be Launched from This Yard Within 64 Working Days from the Laying of the Keel

better lines of production than other yards. It is your duty and obligation to the soldiers abroad to take the utmost advantage of this fact and act accordingly.

This division is developing engineers, traveling principally for the purpose of arriving at how the yards are doing at best. Co-operation with these engineers will help, but real co-operation between the shipbuilders of each district, worked out in a proper manner, can double our production in the next six months.

New Orleans Shipbuilding and Port Development

The creation of a lock, fixed-level ship basin, and industrial canal at New Orleans, which has been undertaken through the co-operation of officials and commercial interests of that city, will make possible a great development of the commerce of the port and furnish shipbuilding facilities which promise to be of special value to the nation under existing conditions.

The project will have an economic effect on the trade and industry of twenty-one States, or 49 percent of the total area of continental United States—the Mississippi Valley. It has been made possible through proceedings which have

Small Ships Excluded from Transatlantic Voyages

Steamers of less than 2,500 deadweight tons will not be permitted to clear for a transatlantic voyage or to engage in other long-voyage trade, under orders recently promulgated by the Shipping Board.

"This ruling has been adopted," it was announced, "as a measure of conservation and economical use of tonnage, since, in the board's judgment, steamers of small tonnage are uneconomical and unsafe in the trades in question. Steamers so excluded will be employed in the coastwise, West Indies or other appropriate services."

To obtain a further measure of control over ships of less than 2,500 tons and over sailing ships, the Shipping Board is contemplating the requisitioning of all American tonnage not already taken over. All steamers of more than 2,500 tons already have been taken over.

AMERICAN SHIPYARDS SHOULD PRODUCE 1,600 SHIPS THIS YEAR, SAYS CHAIRMAN HURLEY.

Yards and Half a Million Men Ready

In a brief address at a recent Army and Navy benefit in New York, when Sousa's march, "The Volunteers," dedicated to the shipbuilders of America, was rendered for the first time, Chairman Hurley said:

"We have the shipyards practically completed. The materials will be in the yards very shortly. We require man power and the support of the American people. Our task is a serious one. It will take millions of tons of shipping to overcome the menace of the submarine, but with the American workman—who is the most skilled and efficient in the world—and efficient management in the shipyards, I am optimistic as to the tonnage we will produce this year.

Progress Getting Its Stride

"We have 130 shipyards, with 700 ways, and a half million men. We should produce about 1,600 ships. The winter has been the most severe in many years, but our programme is now getting into its stride. I am glad to tell you that during this month we expect to place in service twenty-six complete ships, and launch thirty-four in addition.

"It has been gratifying to me to learn of the response which has been made to the call for the Shipyard Volunteer Reserve of 250,000 additional workmen, who stand ready to go to the shipyards when needed. Every State has been heard from in wonderful numbers."

Indian Names Selected for 120 New Ships by Mrs. Woodrow Wilson

The 120 vessels to be launched by the American International Shipbuilding Corporation from the Hog Island ways have been named by Mrs. Woodrow Wilson, wife of the President.

The names selected by Mrs. Wilson are of pure Indian origin, many of the most familiar tribes being thus appropriately recognized.

Maxim "Non-sinkable" Ship to Be Built

The Shipping Board has decided to build a vessel along the line designed by Hudson Maxim. Several methods for protecting vessels from submarine attack have been considered, and the board is now engaged in making special tests of these. Mr. Maxim's principle is along the line of inside protection—that is, intended to keep a vessel afloat after it has been damaged by a torpedo.

Merchant Marine Growing

The growing American merchant marine was increased by 399 seagoing vessels in the last six months of 1917, Government officials report, or an average of more than two a day.

Figures previously made public showed that more than 1,000,000 tons of shipping were added to the American merchant marine in 1917.

NEW SHIPYARDS AND EXTENSIONS PLANNED

Three Companies Organized to Build Concrete Vessels

The American Concrete Shipbuilding Company has been organized at Tacoma, Wash., with the intention of building concrete ships of large size. L. Y. Stayton is president.

The Galveston Dry Dock & Construction Company, Galveston, Tex., has been incorporated, with H. H. Langham president, and T. J. Anderson, consulting engineer. The company is planning the construction of a floating dry dock and machine shops, to cost nearly a million dollars.

Work has been begun at Toronto on the two million dollar shipbuilding plant of the Thor Iron Works. This shipyard, of which Christoffer Hannevig, Inc., 139 Broadway, New York, is the parent concern, is the Dominion Shipbuilding Company. A permit has been obtained to erect a $175,000 work shop and general machine plant.

The Norfolk Concrete Boat Company has been organized at Norfolk, Va., with a capital stock of $1,000,000. Fred Doty is president of the company, which is planning the construction of a shipbuilding plant on the Elizabeth river.

The West Coast Shipbuilding Company, Everett, Wash., has been incorporated for the purpose of building concrete ships for the French government.

The Curtis Bay Shipbuilding Company has been incorporated, with a capital stock of $2,000,000. It is planning to build a yard at Curtis Bay near Baltimore, Md., for the construction of steel ships.

The Weehawken Dry Docks Company, Weehawken, N. J., has purchased more than seven hundred acres of land near Peekskill, N. Y., on the east bank of the Hudson River, and will, according to report, spend about $4,000,000 for a shipyard. The company is also reported to have received contracts from the United States Shipping Board to build fourteen steel vessels of 7,500 tons, twelve concrete vessels of 3,500 tons and one hundred barges.

The Continental Shipbuilding Company, Selah Masten, president, has opened an office at 103 Park avenue, New York, and will soon be in the market for the equipment necessary for its new steel shipyard at Yonkers, N. Y.

The Ferro-Concrete Shipbuilding Corporation, 149 Broadway, New York, and the Fougner American Steel Concrete Shipbuilding Company, 18 East Forty-first street, New York, are planning to build shipyards on the Atlantic coast for the construction of concrete vessels for the United States Shipping Board.

The Foundation Company, 233 Broadway, New York, which has built several shipyards on the Atlantic and Pacific coasts, is planning the erection of another plant on the Savannah River near Savannah, Ga.

The Francis Cobb Company, Rockland, Me., has been taken over by the Francis Cobb Shipbuilding Company. The shipyard will be enlarged to take care of new contracts. The officers of the new company are H. Nelson McDougall, president, and Benjamin C. Perry, treasurer and general manager.

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Ships Loading with Coffee for the Allies at a Brazilian Port

The Potomac Shipbuilding Company, Quantico, Va., is planning the construction of a shipyard to cost about $200,000. George R. Collins, Colorado building, Washington, D. C., is president.

Work on the plant to be built by Henry Ford on the meadows near Jersey City, N. J., for the construction of submarine chasers, will be rushed, with the intention of allowing operation before July 1.

The United States Shipbuilding Corporation, San Diego, Cal. (formerly located in Los Angeles), has begun the erection of a steel fabricating shop and will specialize in the construction of all-steel vessels.

The American Shipbuilding Company, Colon H. Livingstone, president, 1249 Kenyon avenue, N. W., Washington, D. C., has had plans and specifications drawn by Frederick T. Ley, Springfield, Mass., for a shipbuilding plant at Jones' Point.

The Mobile Shipbuilding Company, Mobile, Ala., W. L. Kelly, president, has increased its capital stock from $100,000 to $1,000,000.

The Camden Iron Works, Camden, N. J., is reported considering the construction of extensions to its plant for shipbuilding work.

The Jahncke Shipbuilding Company, New Orleans, La., Ernest L. Jahncke, president, will build an 8,000-foot drydock for Government work, in accordance with an agreement recently made.

The Maritime Engineering Corporation has been incorporated, with a capital stock of $1,250,000. The company plans to build a steel shipyard at Elizabeth City, N. C.

The Société Normande de Constructions Navales, with offices at 16, Boulevard Malesherbes, Paris, France, has been organized, and is planning the construction of several drydocks. The capital stock is 20,000,000 francs.

SHIPBUILDING CONTRACTS

Orders Booked for the Construction of New Ships

The annual naval appropriation bill just reported by Congress carries $1,325,000,000, and provides for the resumption of construction on the three-year naval programme of battleships, scout cruisers and auxiliaries.

Twohy Bros. Company, Portland, Ore., have received a contract from the United States Shipping Board for the construction of ten steel vessels of about 8,000 tons each. These ships will be built in the yard of the Erickson Engineering Works, in which Twohy Bros. and O. D. Colvin, of Seattle, acquired a half interest.

The Standard Shipbuilding Company, Dominion building, Vancouver, B. C., has received a contract from the Imperial Shipping Board to build ten composite steamers and will establish a plant at Ruskin, B. C.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., H. L. Ferguson, president and general manager, is reported to be building thirty destroyers for the United States navy.

The McDougall-Duluth Company, Duluth, Minn., A. Miller McDougall, general manager, has received a contract from the United States Shipping Board to build ten steel steamships.

The Bethlehem Shipbuilding Corporation, South Bethlehem, Pa., J. W. Powell, vice-president, in charge of construction, has received a contract from the United States Shipping Board to build ten towboats. These will be built at the company's Elizabeth, N. J., plant.

The Crowninshield Shipbuilding Company, Fall River, Mass., will build six towboats for the United States Shipping Board.

The Johnson Iron Works, New Orleans, La., Warren Johnson, general manager, will build six towboats for the United States Shipping Board.

The Newburgh Shipyards, Inc., Newburgh, N. Y., unlike other shipyards building fabricated ships for the United States Shipping Board, is a private enterprise. This company has a contract to build ten fabricated steel steamships and has laid the keel of the first.

Whitney Brothers Construction Company, Superior, Wis., are building four steel tugs.

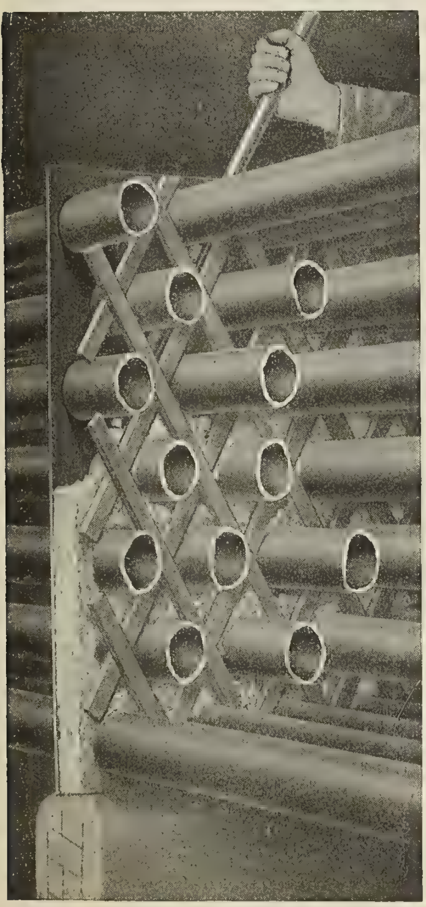
Pushee Brothers, Dennysville, Me., are building two four-masted schooners.

The Wallace Shipyards, Vancouver, B. C., will soon begin work on a 4,350-ton ship.

Boiler Baffles of Plastic Material

As a substitute for baffles for water-tube boilers, consisting of tile, bricks or blocks of refractory material fitted in between the tubes, the Betson Plastic Fire Brick Company, Rome, N. Y., has developed a composition of refractory materials which is shipped in barrels in a moist, plastic condition ready for use. It is pointed out that with this new material it is possible to secure jointless and gas-tight baffles, since the coefficient of expansion is so small that expansion and contraction resulting from variation in the temperature are practically eliminated. Where this material is used, it is emphasized, there is no restriction upon the shape or size of the baffle and any form desired can therefore be secured.

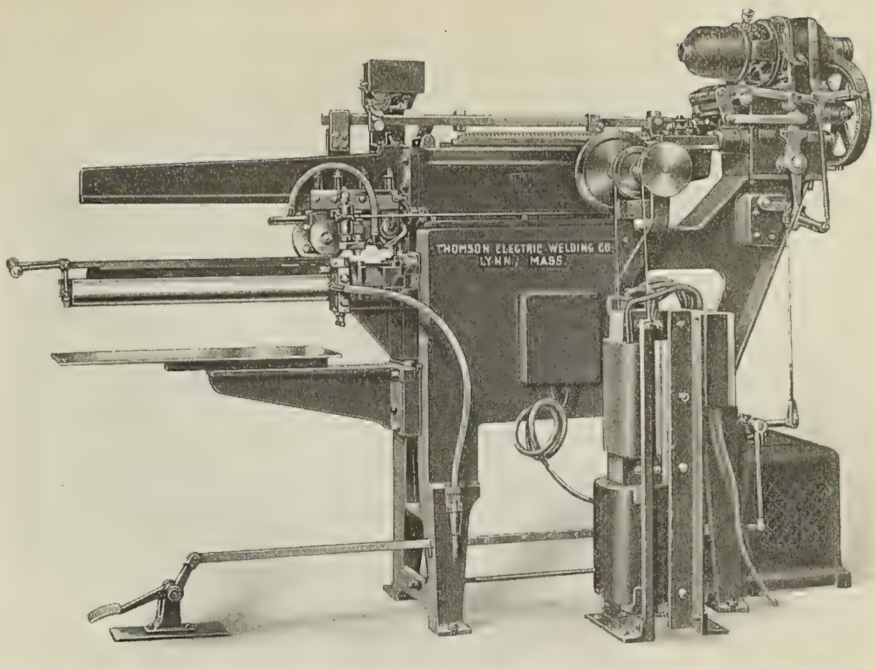
In forming a cross baffle for a water-tube boiler of the Babcock & Wilcox type; for example, the cast iron baffle plate is employed as one side of the mold, while the other is formed by thrusting slats into the diagonals between the tubes as illustrated. The plastic material is then poked down through the diagonals to fill the space between the baffle plate and the slats, it being pointed out that it is sufficiently plastic so that it can be forced out around the tubes and fit them snugly. After the work has been done, the boiler is fired up slowly, the slats being burned out and the plastic material dried and vitrified in place. It is pointed out that this operation occupies only a few hours, after which the full load may be put upon the boiler, and inasmuch as the boiler is operated under full steam pressure before the material is thoroughly set, the expansion of the metal forces the soft material away to the position which it should occupy when the boiler is hot, thus insuring a tight fit between the baffle and the tubes when the boiler is under steam. In forming a longitudinal baffle, blocks of wood are placed between the tubes, above and below the space which it is desired that the baffle should occupy. In this way the plastic material, which is shoved in from the sides or the top or bottom of the tube bank, is confined in place.



Method of Forming Cross Baffle of Plastic Material in Watertube Boiler

Other uses of the material are as a substitute for special forms of bricks or blocks, as, for example, where the front headers of horizontal watertube boilers rest upon the front arch, and for lining furnace and combustion chambers, including the front and rear arches, side and bridge walls, etc.

Electric Seam Welding Machine



Thomson Electric Welding Machine

A line of machines for welding seams in sheet iron and steel by the electric resistance process has been developed by the Thomson Electric Welding Company, Lynn, Mass. It consists of two distinct types, the one that is illustrated being driven through a motor, toothed clutch and worm, while the other is supplied with a speed reducer and crank mechanism. Both machines are equipped with traveling upper dies, while practically any form of lower die and jig necessary for handling any variety of can, cylinder or cone can be supplied.

The machine illustrated is intended primarily for welding the longitudinal seams on pieces such as cans, stove parts, flat pieces and rectangular shapes, such as metal boxes where the material does not exceed No. 16 gage in thickness and the length of the seam is not more than 24 inches. The limits between which work can be handled range from 3½ to 20 inches in diameter and 8 to 24 inches in length. In operation, the piece to be welded is secured in a specially designed jig on the lower horn or arbor and pressure applied to the treadle. This engages the clutch of the driving mechanism, and causes the welding roller on the upper horn, which is actuated by the movement of a screw, to come forward. The current is automatically turned on when the welding roller makes contact with the stock and passes through the material to be welded to the lower copper horn, and thence to the transformer, thus completing the circuit. The resistance of the metal being welded is relied upon to generate a welding heat so that the pressure caused by the roller gives a continuous weld for the entire length of the seam. The current is automatically turned off when the roller reaches the end of the seam and the roller is returned to its original position, thus permitting the welded piece to be removed from the jig and replaced by another.

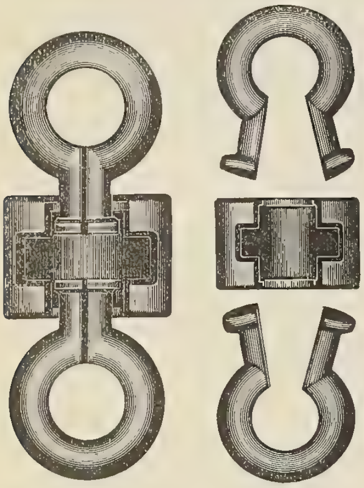
The machine is equipped with an adjustable-speed motor which provides a range equivalent to from 7 to 13 strokes every minute. An hourly output of as high as 200 24-inch welds has been obtained, and where the seam is not so long this figure can be increased, depending upon the character, thickness and shape of the stock and the speed of the operator.

The other machine operates in exactly the same way, and is designed for small sheet metal pieces, such as cans, stove

burners, flat pieces, match boxes and revolver magazines, where the length of the seam does not exceed 8 inches. As high an hourly output as 700 welds has been secured from one of these machines, but this figure is governed by the character, thickness and shape of the stock, the speed of the operator and the number of jigs that can be loaded by the helper.

One Minute for Chain Repairs

A combined swivel and chain repair link (patented) is the unique invention recently placed on the market by the Cleveland Galvanizing Works Company, Cleveland, Ohio. Although it has been on the market but a short time, the One-Minute Swivel Repair Link, as it is called, has found considerable favor among chain users because of its versatility, strength and simplicity, being constructed of but three parts, which can be put in place in the chain with a hammer, pair of pliers or a vise. It may be used with welded, weldless or flat link chain, and is furnished in three sizes for use with the different sizes of chain. An interesting folder has been issued, describing and illustrating the repair link, copy of which can be had by writing the manufacturer.



Combined Swivel and Chain Repair Link

(*Photograph copyright by Press Illustrating Service, Inc., New York*)
Three-Masted Wooden Schooner Recently Launched at Harrington, Me.

Twenty-One Shipbuilding Companies Chartered in Mississippi Last Year

The following twenty-one companies have been chartered in the State of Mississippi during the past year:

Gulfport Shipbuilding Company, $50,000; International Shipbuilding Company, $50,000; City of Pensacola Ship Company, $150,000; City of Houston Ship Company, $200,000; Gulfport Shipbuilding and Manufacturing Company, $5,000; City of Gulfport Shipbuilding Company, $200,0000; Biloxi Shipyard and Box Factory, $10,000; City of Beaumont Ship Company, $200,000; City of Mobile Ship Company, $200,000; City of Dallas Ship Company, $200,000; Dierkes-Blodgett Shipbuilding Company, $150,000; Arrow Boat Company, $25,000.

International Shipbuilding Company, capital increased from $50,000 to $200,000; Mississippi Shipbuilding Company, $100,000; Hodge Ship Company, $200,000; Coast Ship Company, $100,000; City of Galveston Ship Company, $200,000; City of Lafayette Ship Company, $200,000; City of Orleans Ship Company, $200,000; City of Austin Ship Company, $200,000; City of Waco Ship Company, $200,000.

(*Photograph copyright by Press Illustrating Service, Inc., New York*)
Wooden Ships in Frame at Harrington, Me.

Evening Course in Ship Drafting and Ship Calculation Given at Pratt Institute

A new course of instruction, especially arranged to serve the present national need for increased productive efficiency in ship and boat building is being given at the Pratt Institute, Brooklyn, N. Y.

The instruction is planned to aid ship draftsmen of limited experience to extend and broaden their practical ability as draftsmen and designers in the great shipbuiling industry now rapidly developing in this country. It is also adapted to the needs of mechanical and structural draftsmen who are transferring to ship drafting. Ship fitters, riggers and others requiring for efficiency in their occupation a practical familiarity with details of ship construction will find this course helpful.

More experienced ship draftsmen may obtain in the advanced term of this course instruction suited to their requirements.

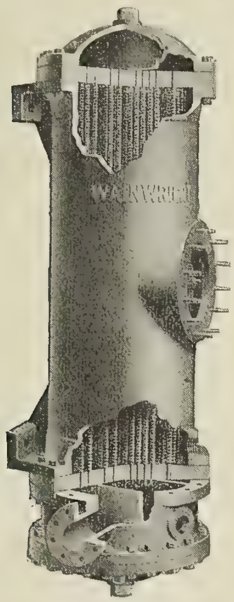
The classes meet three evenings a week, from 7:30 to 9:30 o'clock. A moderate fee, $10.00 for term of twelve weeks, is charged to help meet the cost of instruction. Each student is required to furnish drafting instrument and material for his own use. Application for admission may be made by mail on special forms, which will be sent on request.

Wainwright Marine Feed Water Heater

In the feed heater illustrated, as manufactured by the Alberger Pump and Condenser Company, 140 Cedar street, New York City, the Wainwright corrugated copper tube is used. The general range of the heating is from about 90 to 212 degrees using 5 pounds gage pressure in the heater although

a selection can be made to heat the outgoing feed water to a temperature of about 222 degrees with 5 pounds back pressure (with steam temperature of 227 degrees). With higher back pressure, of course, the temperature of the water leaving the heater would be proportionately increased.

It is claimed that the Wainwright corrugated copper tube agitates all particles of the water, throwing them against the hot tube, so that a much higher rate of transmission is secured in a heater of this style than with plain tubes. All tubes are straight, may



Feed Heater Showing Corrugated Copper Tubes

be inspected by moving a bonnet at the end of a heater farthest from the water connections, and the construction permits replacing of tubes with minimum of effort and delay.

As no steel or wrought iron inside the tube heads is used, and as the water comes in contact only with cast iron and copper, it is claimed that corrosion is avoided and, owing to the fact that no floating heads are used, accidents, due to pulsations of the boiler feed pumps, are avoided.

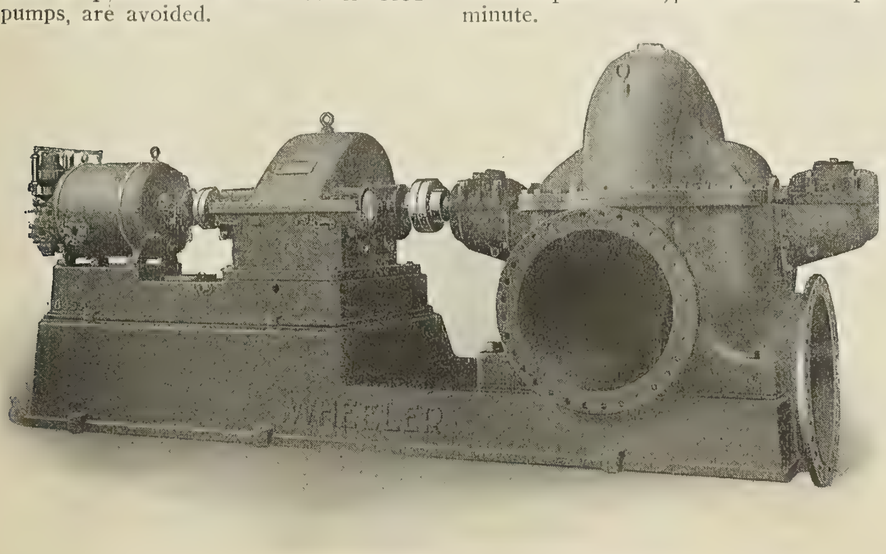
S. S. *Lake Clear* Ready for Launching at Chicago Shipbuilding Company's Yard on February 28

A New End Suction Centrifugal Pump

Here is a new design of pump, manufactured by the Wheeler Condenser & Engineering Company, Carteret, N. J., that is of special interest because of the unusual position of the suction opening. This opening, it will be noted, is directly beneath and parallel to the end bearing. In this position it is out of the way, yet it is in a convenient place for the erection men, for inspection, for upkeep, etc.

This arrangement makes it possible to place a pumping unit in a room of small ground area, considerably smaller than where the suction end is opposite the outlet end. In many cases this also facilitates the making of pipe connections, sometimes saving elbows and reducing the length of piping more or less.

The capacity of the particular pump shown is 45,000 gallons per minute, against a head of 20 feet. The diameter of the outlet pipe is 36 inches. The speed of the pump is 240 revolutions per minute, and is coupled by a 10 to 1 reduction gear to a steam turbine whose speed is 2,400 revolutions per minute.



Centrifugal Pump, with End Suction, Manufactured by Wheeler Condenser & Engineering Company

Quick Work at Lake Yard

That no time is being lost by the Lake shipbuilders in adding tonnage to the American Merchant Marine was shown at the launching of the S. S. *Lake Clear,* at the yards of the Chicago Shipbuilding Company, Chicago, Ill., on February 28. The *Lake Clear* is a full Welland Canal-size vessel, and was launched at 10 A. M. while at 3 P. M. on the same day the launching material had been cleared away and the keel for a new vessel laid on the same berth. Mr. F. C. LaMarche, general superintendent of this yard, states that the credit for this performance belongs to the different department heads and to their men, all of whom co-operated to their utmost.

Many of the standard Welland Canal-size vessels built by this company were originally ordered for foreign account, but the entire capacity of the yard is now being utilized in the effort to produce as many vessels as possible for the Shipping Board.

First Wooden Ship Launched in the East

The Foundation Company of New York had the honor on March 19 of launching the first wooden ship on the Atlantic coast for the Emergency Fleet Corporation. The vessel is a steamship of 3,500 tons deadweight and was christened the *Coyote.* The length is 281 feet 6 inches and the beam 46 feet. A triple expansion reciprocating engine of 1,400 horsepower will give the vessel a speed of 10 knots.

In the construction of this vessel 132,000 feet of timber were used, 715,000 pounds of metal fastenings, 58,000 pounds of steel strapping, 2,800 pounds of oakum and 2,600 pounds of pitch for calking, 6,000 gallons of paint and 4,000 pounds of white lead and oil.

Supply of Ship Timbers for Atlantic Yards Now Adequate

It was recently announced at the New Orleans office of the Emergency Fleet Corporation that every shipyard along the South Atlantic and Gulf coasts is now supplied with all timbers needed to permit of full operations. Many yards are piling up reserve materials. Maximum speed is being rapidly attained in

rushing to completion the first 200 hulls for Uncle Sam's wooden fleet, it was said. Some of these hulls will go into the water this month.

A number of shipyards are planning to operate day and night, as soon as necessary labor is available. Three eight-hour shifts will be maintained.

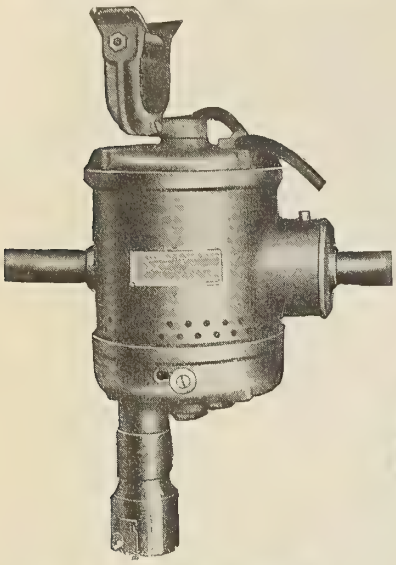


Fig. 1.—Portable Electric Drill

"The situation is very encouraging," said H. D. Foote, assistant director of the Lumber Department of the Fleet Corporation. "Yards are rapidly hitting their stride.

"In spite of great difficulties they have and are still encountering in getting out the big sizes, Southern pine mills are producing ship timbers in increasing volume. No complaints about shortage of materials are now being received from shipyards. We think the work will now proceed rapidly."

Portable Electric Drills and Grinders

At this time, when working in metal and wood are synonymous with carrying on the war, any labor-saving device which can be employed should be put to work at once. Portable electric tools which replace hand operation, save time and labor and increase the output of a given working space. Particularly is this true of a portable electric drill, such as that shown in Fig. 1. Less "elbow room" is required by a workman using one of these devices, and since he can drill a great many more holes per hour, he can replace a number of men who may be given to other tasks. This drill, which is manufactured by Gilfillan Brothers' Smelting and Refining Company, of Los Angeles, Cal., is equipped with gears to give two speeds. These are changed by means of a knob on the bottom of the gear case. The gears themselves are made of chrome nickel steel and run in grease. Ball bearings are used throughout. A $\frac{1}{2}$-inch Standard chuck and a sturdy electric switch are provided. The speed range is 400 revolutions per minute on low speed and 700 revolutions per minute on high speed. Westinghouse motors are furnished.

The same concern also manufactures a tool post grinder adapted for use on lathes. An angle plate can be clamped around the tool post. There is a vertical adjustment of the grinder provided. This grinder is equipped with a Westinghouse $\frac{1}{4}$-horsepower motor, running at 3,400 revolutions per minute. It is provided with a 6-inch by $\frac{3}{8}$-inch grinding wheel, an extension mandrel for

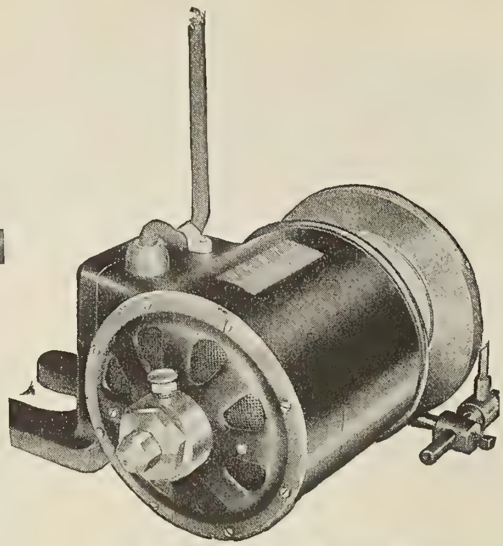


Fig. 2.—Electric Tool Post Grinder

internal grinding, fitted with a $1\frac{1}{2}$-inch by $\frac{3}{8}$-inch wheel, a tooth rest for cutter grinding and an electric attachment plug with $7\frac{1}{2}$ feet of cord.

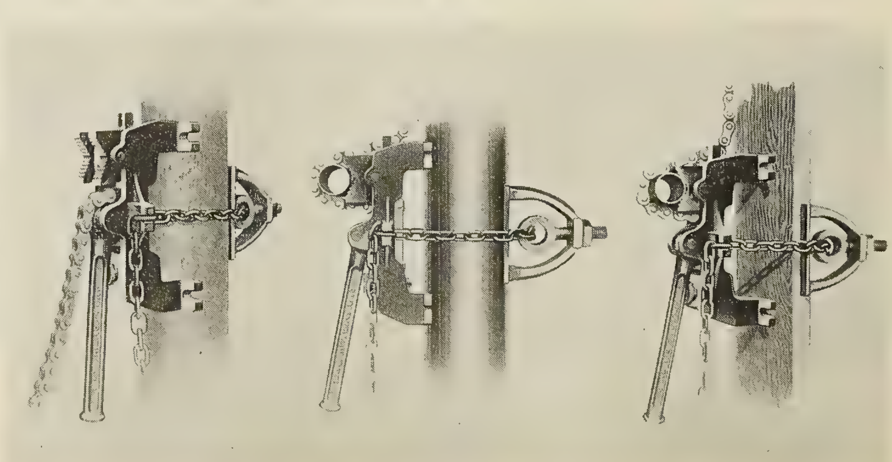
Chaingrip Pipe Vise

The Chaingrip Pipe Vise, manufactured by the Gerolo Manufacturing Company, Old Colony Building, Chicago, is a simple, portable vise, which can be moved from one location and mounted at another in a moment's time. It eliminates long walks to the distant bench vise by always being right at hand. It fastens to any kind of a horizontal or vertical support, whether round, square or flat, without the use of bolts. It locks any size pipe or conduit within its limits by the slight push of a lever. No previous adjustment is necessary. Hence, it saves labor and effort, both by its portability and instantaneous operation.

The base support of the Chaingrip is squared out in the form of an inverted V, at the sides of which are bolt lug feet, to be used only in case the vise is to be permanently bolted in one position. Hence, it will conform to a round, square or flat surface. A clamp support on the opposite side of the column is a part of the Chaingrip equipment. It is a bell section shape, having a boss at the top, through which a threaded supporting eye-bolt passes free. A heavy nut, resting on the top of the boss and engaging the threaded eye-bolt, adjusts the tension of the chain passing through the eye of the eye-bolt. The base of the clamp support is squared out in a manner similar to the vise base, in such a way that it fits the same shaped surfaces.

A heavy wrought-iron chain is riveted on one side of the vise base. It passes around the supporting column, through the eye of the eye-bolt in the clamp support, and thence to the other side of the vise base, a link being held securely in position in a socket. Tightening of the eye-bolt nut tightens the supporting chain and holds the vise vigidly in position.

The Chaingrip Vise locks a pipe or conduit firmly between a double set of steel pipe jaws on one side, and a heavy close linked steel chain on the other. The locking motion is accomplished by the movement of the handle toward the vise. This handle fulcrums on a steel pin, which projects through two bosses, one on either side of the frame of the vise. Directly beneath this fulcrum point the handle takes the shape of a cam, which in turn operates against a movable horizontal bar. To one end of this bar is riveted the steel gripping chain which passes around the pipe or conduit, and locks in a steel socket. The other end, or fulcrum point, of the bar is supported by a threaded bolt, the enlarged, knurled head of which rests upon a boss on the base of the vise. Rotation of the head of the bolt raises or lowers the fulcrum point of the bar, and forms an adjustment of pressure exerted by the other end of the bar on the gripping chain when the handle of the vise is in a locked position—i. e., when it is at the end of its travel toward the vise, and the largest radius of the cam is directly beneath the fulcrum point of the handle support.



Chaingrip Pipe Vise Attached with Ease to Different Types of Supports

TWENTY-THREE NEW VESSELS ESTIMATED OUTPUT FOR MARCH

Fifteen Steel Ships, Aggregating 114,100 Tons, Delivered During February

The United States Shipping Board has made public the following:

Fifteen steel vessels, aggregating 114,100 tons, were completed and delivered in American shipyards in February for the Emergency Fleet Corporation. It is expected that in March the total number will be increased to 23 vessels, of an aggregate tonnage of 188,275.

Some of the ships included in the March schedule already have been completed.

The following table shows the February record of vessels completed and delivered:

Description	Tonnage	Date of Completion
Cargo vessel	8,800	Feb. 12
Do	8,800	Feb. 4
Do	9,400	Feb. 4
Do	8,800	Feb. 4
Do	10,000	Feb. 3
Do	6,000	Feb. 6
Tanker	14,900	Feb. 14
Collier	8,600	Feb. 15
Cargo vessel	8,800	Feb. 22
Do	8,800	Feb. 26
Do	8,800	Feb. 16
Do	3,100	Feb. 14
Do	3,100	Feb. 14
Do	3,100	Feb. 25
Do	3,100	Feb. 27
Total	114,100	....

Estimated Deliveries for March

The estimated deliveries for March are shown in the following table:

Description	Tonnage	Date of Completion
Tanker*	10,475	Feb. 28
Cargo vessel	8,800	Mar. 4
Do	3,300	Mar. 6
Do	4,500	Mar. 1
Do	7,500	Mar. 1
Tanker	7,000	Mar. 7
Do	10,475	Mar. 4
Cargo vessel	8,800	Mar. 9
Do	7,500	Mar. 10
Do	6,200	Mar. 11
Tanker	12,650	Mar. 15
Cargo vessel	8,800	Mar. 15
Collier	8,600	Mar. 15
Tanker	10,300	Mar. 15
Cargo vessel	8,800	Mar. 15
Do	8,800	Mar. 17
Collier	4,900	Mar. 20
Cargo vessel	10,500	Mar. 25
Do	3,300	Mar. 25
Tanker	9,000	Mar. 27
Cargo vessel	8,800	Mar. 30
Do	8,800	Mar. 30
Tanker	10,475	Mar. 31
Total	188,275	....

* Accepted March 1.

Year's Growth in Number of Shipyard Workers

With the advent of the volunteer workers, the United States will have about 450,000 skilled men actually at work in shipyards. That shows what can be done in a little over a year's time. The following figures speak for themselves. In 1916 the wage-earners in steel shipyards of the country numbered:

Steel shipyards	43,582
Wood shipyards	1,380
Total	44,962

On January 1, 1918, the workers numbered:

Steel shipyards	181,273
Wood shipyards	23,437
Total	204,710

Add the 250,000 shipyard volunteers and the grand total is 454,710 shipbuilders.

PERSONAL

Frederick Holbrook, of Holbrook, Cabot & Rollins, Inc., engineers, has been placed in charge of the Hog Island shipyard as managing director and president of the American International Shipbuilding Corporation, succeeding Dwight T. Robinson, resigned.

D. H. Cox, of Cox & Stevens, naval architects, New York, has been appointed manager of the division of steel ship construction, United States Shipping Board Emergency Fleet Corporation, succeeding Rear Admiral F. T. Bowles, who has been appointed assistant general manager of the Emergency Fleet Corporation.

L. T. Bush resigned as chief executive officer of the War Board for the port of New York on February 19. Mr. Bush holds the appointment of Chief of Embarkation of the Port of New York and Director of Harbor and Terminal Facilities.

A. C. Voorhees, chief submarine draftsman of the California Shipbuilding Company, Long Beach, Cal., has been appointed assistant to the general superintendent of the Schaw-Batcher Company Pipe Works, Burlingame, Cal., which has contracts for eighteen freighters for the Emergency Fleet Corporation.

A. Cyril Rimmer, formerly assistant to the president of the Samuel L. Moore & Sons Corporation, Elizabeth, N. J., has been appointed assistant to the vice-president and general manager of the Federal Shipbuilding Company, New York.

Loyall A. Osborne, of New York, vice-president of the Westinghouse Electric & Manufacturing Company, and chairman of the executive committee of the National Industrial Conference Board, has been appointed by the Secretary of Labor a member of a committee on industrial peace during the war.

W. H. Thompson, for many years prominent in the heavy electric traction work in the Westinghouse Electric & Manufacturing Company, has resigned to accept the position of works manager of the Fairmont Mining Machinery Company, Fairmont, W. Va., makers of coal mining equipment.

William T. Price has recently resigned as manager and chief engineer of the De La Vergne Machine Company to become president of the P-R Engine Company, of New York, and second vice-president of the Rathbun-Jones Engineering Company, of Toledo, which will undertake the sale and manufacture, respectively, of Price-Rathbun stationary and marine oil engines, built in accordance with the new principle of fuel injection developed by Mr. Price during the past several years. The P-R Engine Company has its main office at 110 West Fortieth street, New York, and other offices at Philadelphia, Baltimore and Toledo.

William Alexander has been appointed superintendent of the Groton Iron Works, Groton, Conn., succeeding Thomas Spence. George K. Warner has been appointed superintendent of machinery and William H. Godfrey superintendent of woodwork at the same yard.

OBITUARY

Frank J. Hurley, of the Independent Pneumatic Tool Company, died at his home in East Orange, N. J., on March 10, aged 29.

George Von L. Meyer, former Secretary of the Navy, died at his home in Boston on March 9 after an illness of several weeks, aged 60. Mr. Meyer was ambassador to Italy from 1900 to 1905, and ambassador to Russia from 1905 to 1907. He was Postmaster-General under President Roosevelt, and Secretary of the Navy under both Roosevelt and Taft administrations.

Lord Brassey, former Civil Lord of the British Admiralty and founder and first editor of the *Naval Annual*, died in London on February 23 aged 82. Lord Brassey was a former president of the Institution of Naval Architects and member of Parliament. From 1895 to 1900 he was Governor of Victoria. He was an honorary associate member of the Society of Naval Architects and Marine Engineers.

Col. Edwin Augustus Stevens, Government-Inspector of Shipyards, and honorary vice-president of the Society of Naval Architects and Marine Engineers, died on March 8 in Washington, D. C., aged 60. Colonel Stevens was the second son of Edwin Augustus Stevens, founder of the Stevens Institute of Technology, Hoboken, N. J. He was educated at St. Paul's School, Concord, N. H., and Princeton University, afterward receiving a degree in engineering at Stevens Institute of Technology. Colonel Stevens designed the first screw ferryboat, the *Bergen*, which is still in service on the Hudson River. He was consulting engineer for the city of New York in connection with the construction of ferryboats for the municipal ferry to Staten Island, and also had charge of the designs of ferryboats for the Lackawanna Railroad. For years he was president of the Hoboken Ferry Company. In 1911, Woodrow Wilson, then Governor of New Jersey, appointed Colonel Stevens State Public Road Commissioner. More recently he was made a member of the State Highway Commission, and after the entrance of the United States into the European war President Wilson appointed him Government-Inspector of Shipyards. Colonel Stevens was a life member and vice-president of the American Society of Mechanical Engineers, and honorary vice-president and life member of the Society of Naval Architects and Marine Engineers. He was also a member of the American Society of Civil Engineers and the Institution of Naval Architects.

Commodore Jacob W. Miller, U. S. N., retired, organizer of the State Naval Militia, and member of the Board of Governors of the New York State Nautical School, died suddenly of pneumonia at his home in New York on March 8, aged 70. Commodore Miller served in the United States Navy from 1867 to 1884. After resigning from the navy he became an officer in the Nicaragua Canal Company. Later he became manager of the Providence & Stonington Steamship Company, and afterwards manager of the combined Sound Steamship Lines and vice-president of the New York, New Haven & Hartford Railroad. When the Cape Cod Canal Company was formed he was elected vice-president and manager of that corporation.

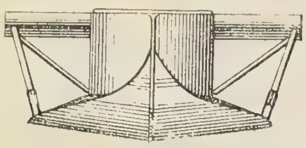
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by George A. Hutchinson, Esq., registered patent attorney, Washington Loan and Trust Building, Washington, D. C.

1,223,319. FLYING-BOAT HULL. GLENN H. CURTISS, OF BUFFALO, N. Y., ASSIGNOR TO CURTISS AEROPLANE AND MOTOR CORPORATION, A CORPORATION OF NEW YORK.

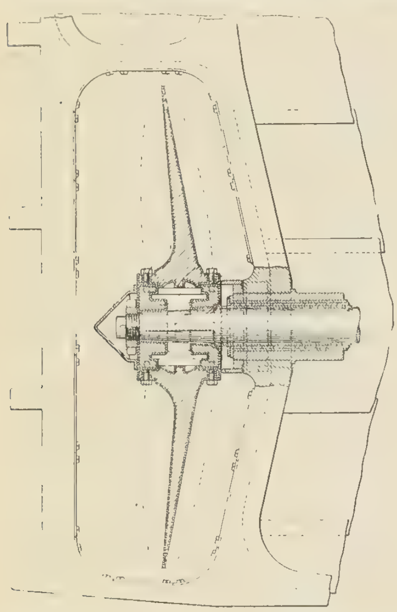
Claim 1.—In a hull for flying boats, a hydroplaning bottom, and fin excrescences formed by



extending the bottom planking laterally beyond the chines of the boat body proper. Twenty-two claims.

1,216,549. SHIP PROPELLER. MATTHEWS E. DAVIS, OF NEW YORK, N. Y.

Claim 1.—The combination of an iron or steel hull, with a steel propeller shaft having a fixed sleeve insulated from the hull; a propeller shaft having a fixed sleeve insulated from the hull; a propeller keyed to and also clamped endwise in place on the shaft; and a gasket between the opposed walls of the sleeve and propeller hub; the propeller comprising an iron or steel



propeller-shaped core and a copper-containing metal coating on its surfaces, and the hull being provided with removable zinc plates adjacent the propeller; the copper-containing metal coating resisting pitting and preventing pitting of the coated propeller core and of the portion of the shaft in the propeller hub bore; and the zinc plates in proximity to the propeller protecting the hull against electrolytic action; and the gasket excluding water from access to the shaft at the joint between the opposed walls of said sleeve and propeller hub; and the said metallic coating increasing the strength of the blades cross-sectionally.

1,209,640. HYDROPLANE-BOAT. CLINTON H. CRANE, OF HEWLETT, N. Y., ASSIGNOR TO J. FREDERIC TAMS AND CHARLES KING, DOING BUSINESS UNDER THE FIRM NAME OF TAMS, LEMOINE & CRANE, OF NEW YORK, N. Y.

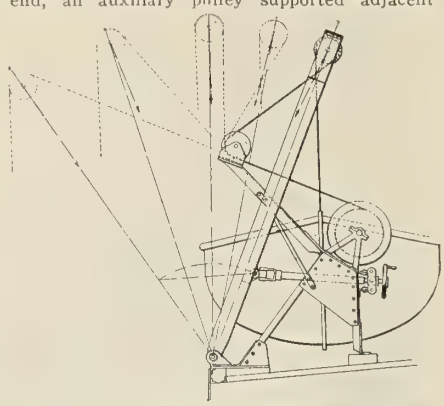
Claim 1.—A hydroplane boat provided with a fixed forward plane member, a wholly submerged after plane member secured to the propeller struts, and rigidly set at a predetermined angle in conjunction with the angle of the forward plane member, a second after plane member directly superimposed above, and of larger area than, said submerged plane member secured to the propeller struts and rudder post, and adapted to rise to, or above, the surface of the water as the speed of the boat increases, and a rudder mounted between said after plane members. Four claims.

1,240,538. APPARATUS FOR RAISING SUNKEN VESSELS. RICHARD M. BROWNE, AND THOMAS D. SCOTT, OF NEW YORK, N. Y.

Claim 1.—A pontoon having a flat side arranged to lie snugly against the side of a vessel, and having a co-extensive flange whereby said pontoon may be bolted to the vessel. Seven claims.

1,246,778. DAVIT. HAROLD F. NORTON, OF NEWPORT NEWS, VA.

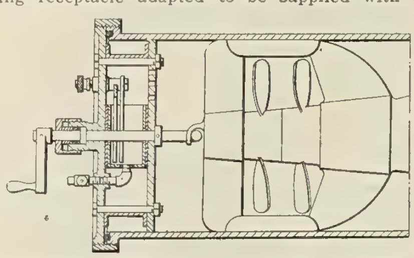
Claim 1.—In an apparatus for transferring a load, the combination of a beam pivotally supported at its lower end, a pulley at its upper end, an auxiliary pulley supported adjacent



the beam independently thereof and a rope passing over the two pulleys, the second pulley being so positioned that the direction of the resultant force acting on the beam lies substantially along the beam for all positions of the beam during the transfer of the load. Thirteen claims.

1,247,417. BREECH FOR TORPEDO TUBES. ONIS MARCUS LEONARD, OF MACY, IND.

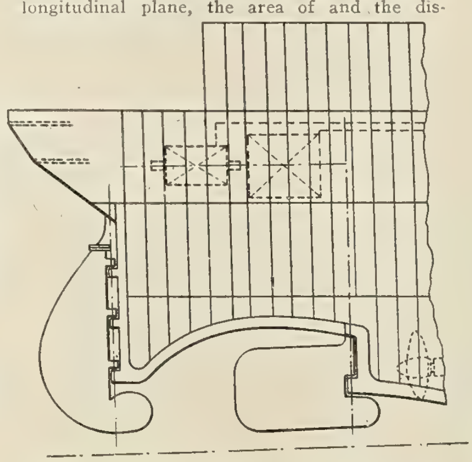
Claim 1.—A device including a torpedo tube provided with a breech and having an evaporating receptacle adapted to be supplied with a



gas forming liquid, and means for supplying heat to the receptacle for converting the liquid into gas of the desired pressure. Eight claims.

1,247,448. ARRANGEMENT OF SHIP RUDDERS. GUIDO PO, OF ROME, ITALY.

Claim 1.—A ship provided with two rudders placed one behind the other in the middle longitudinal plane, the area of and the dis-



tance between the rudders being such as to develop equal and opposite turning moments when set over by equal angles in opposite directions. Two claims.

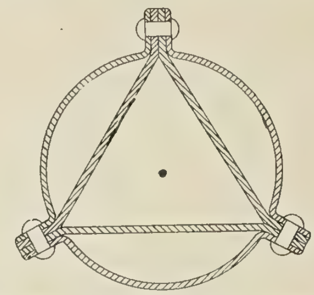
1,223,154. METHOD OF RENDERING SHIPS UNSINKABLE. WILLIAM T. DONNELLY, OF BROOKLYN, N. Y.

Claim 1.—The method of loading ships, which consists in confining to such an extent only that it will float in water and will afford its between decks watertight container and loading container with cargo portion of the buoyancy required to maintain the ship afloat when water logged. Two claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

108,525. "THE IMPROVED METHOD OF CONSTRUCTING IRON AND STEEL MASTS, DERRICKS, DERRICK POSTS, PILLARS, TUBING AND THE LIKE." T. W. SIDGWICK, OF MIDDLESBOROUGH-ON-TEES.

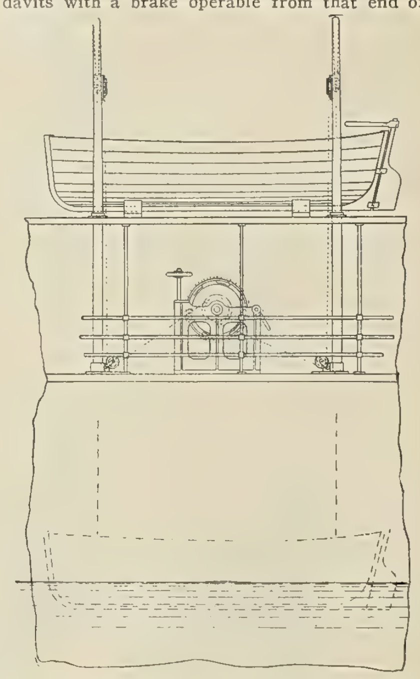
The tubular structure consists of three sectional parts formed of steel plates pressed or



rolled to the required curved form. These parts are formed with radial longitudinal flanges at the edges, and between them are disposed longitudinal plates formed with flanges which are clamped between the flanges by rivets so that a longitudinal inner strengthening core of triangular section is formed within the outer tubular shell or casing and extending for the whole or any desired part of its length. The plates thus built up may be in one length to form the complete article, say, for example, a mast or derrick or two or more such structures may be placed end on end and fastened together in any appropriate way.

109,699. "IMPROVEMENTS IN AND CONNECTED WITH MECHANISM FOR RAISING AND LOWERING SHIPS' BOATS AND THE LIKE." P. J. SMITH, OF HARROW, AND T. BREDENBERG, OF EALING.

The adaptation to slewing davits of an arrangement comprising a winch or the like located between the davits or alongside one of the davits with a brake operable from that end of



the winch or the like adjacent the ship's side. The boat is lowered on an even keel, it being impossible to lower one end at a faster rate than the other. The boat can be lowered in safety even when the ship is traveling at a moderate speed through the water. The mechanism can be fitted to existing davits at a very low cost. Lowering being speedy and in complete control of one man, who watches the descent, the risk of the boat fouling the ship's side and being damaged is greatly lessened. For heavy lifeboats the falls may be passed around a block adapted to be hooked to the boat and the free end attached to davit head, thus halving the strain on the falls.

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"For God's Sake, Hurry Up!"

PERHAPS no phrase better expresses what has been in the minds of countless Americans in recent months than the above plea uttered by the late Joseph H. Choate in his last public address and repeated the other day by Honorable Crawford Vaughn, ex-Premier of South Australia, at the shipping conference of the Chamber of Commerce of the United States. No one better understood the need for haste when we entered the war a year ago than the shipbuilders and shipping men of the country whose intimate knowledge of over-seas transportation problems left no illusions as to the size of the task ahead. "It was useless," said the Secretary of War, "for us to send men to training camps when we had no way of transporting a vast number of soldiers to France." Perhaps so, but why should it have taken a year for the government to come to the common-sense conclusion that better progress might be made in furnishing the means of transportation if a shipbuilder experienced in the construction of merchant ships were placed in charge of shipbuilding operations? With Charles M. Schwab as Director General of the Emergency Corporation we look for a prompt speeding up of merchant shipbuilding. As a former private shipbuilder he controlled some 40 percent of the output of vessel tonnage in this country, to say nothing of being the head of one of the largest steel making corporations. At his call are some of the most efficient and best qualified men in every department of the shipbuilding industry. No further apprenticeship is necessary in this quarter. Action is needed and action of the most vigorous kind can be expected.

A Bigger Shipbuilding Programme

WHILE details of the shipbuilding programme now being considered by the Shipping Board for the coming months have not been made public there is little doubt but that a much larger output of merchant tonnage will be sought next year than has hitherto been contemplated. It may be that the mark will be set at 10,000,000 tons for 1919, with a continuation of this rate of production for 1920. It has often been maintained by shipbuilders whose estimates are worthy of the most careful consideration that a most creditable performance will have been made if 3,000,000 tons of merchant shipping are completed in the United States this year. Whatever the result may be, the great expansion of the shipbuilding industry which will certainly be called for next year means that further shipbuilding facilities must be provided either by the establishment of new yards or the expansion of existing yards. Just as we are going to press contracts for twenty-nine more ships of nearly a quarter of a million tons have been let. When the 730 shipways already provided are operating at maximum capacity and delays incident to non-delivery of materials, lack of housing facilities and the training of shipyard workers are eliminated, something like the real capacity of our newly organized shipbuilding industry will be realized. Rivalry among the shipbuilders for the quickest production of ships and among the various departments in individual yards for records in riveting and in other work is already having a beneficial effect in speeding up the output, particularly so because it gives the individual workmen a chance to win public recognition and receive credit where credit is due. The great need for the rapid expansion of our merchant marine, however, should not be gaged solely by the immediate necessity of transporting troops to France, although this is the first consideration, but it should provide for the carrying on of the world's commerce, upon which all of the allied countries are dependent.

Credit Where Credit Is Due

WITH the resignation of Theodore E. Ferris, after nine months' service as naval architect of the Shipping Board, during which time he designed or passed upon and approved the plans of some 1,200 vessels representing an approximate value of over $1,000,000,000 (£205,000,000), scant recognition has been accorded to a very able man for a record of service never before equaled in the history of shipbuilding. In the practice of his profession as a naval architect, Mr. Ferris early won an enviable reputation as a designer of merchant vessels. Specializing in this branch of shipbuilding, he was entrusted with the design and supervision of many of the finest coastwise passenger and freight steamers under the American flag, ranging from 3,000 to 10,000 tons capacity, for such steamship companies as the Munson, Clyde, Mallory, Ward, New York and Porto Rico and other lines. In this work Mr. Ferris had for years been intimately associated with the leading shipbuilders of the country, and hence it was but natural that when the present crisis arose the Shipping Board should seek his co-operation in the task of creating a great emergency fleet. How ably he met the great responsibilities that were entrusted to him is eloquently attested by the splendid results that were accomplished in the crucial months for the first year of our participation in the war. Notwithstanding the adverse opinions of many of the shipbuilders in the country, Mr. Ferris did not hesitate, after careful investigation, to indorse the so-called fabricating method of building ships which is turning out so successfully in this country and which now promises in part to revolutionize shipbuilding throughout the world. It is seldom that the opportunity comes in professional life to render such signal service as that of Mr. Ferris or to un-

dertake work for the successful accomplishment of which greater credit is due.

Nothing New Under the Sun

In our April, 1915, issue, there appeared an article by William T. Brown, then master ship fitter at the League Island Navy Yard, Philadelphia, but now assistant superintendent of the mechanical division, Balboa, Canal Zone, which dealt with certain standardization methods of ship construction and the application of multiple punching, features which, in reality, covered all the essential details of the present-day methods of building so-called fabricated ships. So far as is known, this was the first article published in which the application of these particular methods to ship construction was suggested. Like all pioneer work, however, the thought and idea were too far advanced for shipbuilders at that time, but now, due to National necessity, when it has become essential that some method of intensified production must be developed, the idea first advanced by Mr. Brown has been incorporated and is now being used with marked success. That there is "nothing new under the sun," therefore, applies to the fabricated shipbuilding idea as well as to many other lines of development in the engineering field.

Community Aid for Shipbuilders

If the shipbuilders are to succeed in carrying out their gigantic shipbuilding programme, they must be given every aid and assistance possible from the communities in which the shipyards are located. This fact was recognized early in the period of the war by the Chamber of Commerce of the United States and a War Shipping Committee was organized to co-operate with the United States Shipping Board and to secure the aid of the shipbuilding communities. To bring the shipbuilders and the business men of the shipbuilding communities into close co-operation, war shipping committees were appointed in every shipbuilding district throughout the country and an office with a competent staff was established to keep in touch with all these committees and to send out to them from time to time suggestions for new lines of helpful activity. That much has been accomplished in this respect by the National Chamber of Commerce was brought out at its recent annual convention in Chicago. The War Shipping Committee began in a small way at first by suggesting and then providing a badge for ship workers which would give them recognition as war workers throughout the community and thus lead them to feel that they were doing their share, although not in uniform, or at the front. Next, posters were provided, appealing for shipyard workers, placards were furnished to be attached to ship material in transit and steps were taken to organize a reserve of shipyard workers, a branch of the work which was soon taken over by the Government, solving one of its most important problems. Every effort was made by arranging meetings, providing speakers, displaying pictures, etc., to arouse patriotism and zeal and stimulate the shipbuilding community to co-operate with the shipbuilders and supply without delay whatever assistance might be needed, whether in the housing or transportation of shipyard workers or furnishing help and supplies.

As an example of how effective this work could be made, the work of the War Shipping Committee of the Merchants Association of New York can be cited. In the New York district there are twenty shipyards working on Government contracts. On January 1 they were employing about 30,000 men with the prospect of having nearly double this number by the middle of the summer. Taking up only non-technical problems connected with shipbuilding, it was first found necessary to secure a satisfactory supply of labor. Coupled with this was the problem of the erection of additional houses in the vicinity of the shipyards; the construction of new transportation facilities and improvement of existing facilities; the installation of schools for training unskilled and semi-skilled shipyard labor; the return to the shipyards of skilled men taken by the first draft; the exemption of skilled workmen from future drafts and a uniform employment policy to assure a creditable and sufficient supply of labor at all shipyards and the elimination of so-called stealing of labor. All of these problems and many others were given immediate and energetic attention, with the result that the shipbuilders received substantial aid in speeding up their work.

Should Business Men Help the Transference of Their Skilled Employees to Shipyards?

In discussing the above subject at the recent annual meeting of the Chamber of Commerce of the United States, one member who had just visited twenty-five shipyards on the South Atlantic and Gulf coasts pointed out two needs that have materially retarded ship construction. First, the shipbuilders did not receive material as fast as they needed it, and second, the shipbuilders were unable to secure anything like as many skilled ship workers as they required. It appeared that the lack of skilled workmen had more to do with the slow progress than anything else and constituted the real handicap in the rapid building of ships. Recognizing this difficulty, a remedy was proposed, which, it was believed, the business men of the country could supply. The remedy was simply this, that the business men in non-essential industries be urged to send the most efficient executives and skilled workmen to the shipyards when and where they are needed to speed up shipbuilding. While it is true that not every executive or skilled workman may prove competent in the actual work of shipbuilding, nevertheless such a plan would mean that at least men who have attained success in their own special lines of endeavor will be available for use if needed, and it is safe to assume that a man who is either a competent executive or a skilled workman can accomplish better results in the highly specialized work of shipbuilding than ordinary or semi-skilled labor.

Fabricated Method of Shipbuilding Proving a Success

In a recent letter to Henry R. Sutphen, vice-president of the Submarine Boat Corporation, Theodore E. Ferris, former naval architect of the Shipping Board, has the following to say regarding the fabricated ships building at the company's yard:

"The work as a whole, and much to my surprise, is better than that usually turned out in the shipyards under the old tradition method of steel ship construction. From what I have seen at your yard on the work now advanced, there is absolutely no question in my mind as to the success of the fabricated method in steel ship construction. This method will be a revelation in steel ship construction over the old tradition methods. As you were the pioneers, and had the foresight to see its possibilities, certainly great credit is due you."

Directors of Merchant Shipbuilding in the United States and Great Britain

(Copyright by Press Illustrating Service, N. Y.)
The Right Honorable Lord Pirrie, K. P., Controller-General of Merchant Shipbuilding in Great Britain

(Copyright by Underwood & Underwood, N. Y.)
Charles M. Schwab, Director-General of the Emergency Fleet Corporation

WITH the appointment of Charles M. Schwab as Director General of the United States Shipping Board Emergency Fleet Corporation, and the Right Honorable Lord Pirrie, K. P., as Controller-General of Merchant Shipbuilding in Great Britain, the two foremost shipbuilders in the world now control the output of merchant tonnage in the two greatest maritime nations. Both of these appointments have been received with universal satisfaction by the allied nations and there is every reason to believe that the rate of production of merchant vessels will speedily be increased.

Mr. Schwab takes up his duties as master shipbuilder in America as a fitting climax to a life of personal achievement, unique in the history of a nation of master builders. Measured in the ordinary terms of success there is little that Mr. Schwab has attempted that has not been done, and done well. It is for this reason that in this supreme crisis he has been chosen to undertake the gigantic task of getting into service, in the shortest possible time, the largest possible fleet of merchant ships.

Lord Pirrie, Great Britain's foremost shipbuilder and shipowner, is the head of the great Harland & Wolff shipyard and its subsidiaries. As Controller-General of Merchant Shipbuilding he brings to the British government the most experienced and most highly qualified advice and assistance for carrying out its shipbuilding programme. Lord Pirrie will not become a member of the Board of the Admiralty but will have direct access to the Premier and the War Cabinet.

"What the Shipping Board Has Done"*

Comprehensive Analysis of Merchant Shipbuilding Situation in the United States—Progress of the Work

BY EDWARD N. HURLEY†

If by the exercise of magic a bridge could be thrown across the Atlantic over which our armies, their artillery and supply trains could move rapidly and unhampered to the battle lines in France, would any military man in Berlin, Vienna, Rome, Paris, London or Washington have any doubt but that the world would be made safe for democracy before the year goes out? We have the men, we have the guns, we have the supplies. But without means of getting them to the front we might as well be without them. And unless we get our men to the battle line we will not win this war.

So it all comes back to ocean transportation—to the vital need of ships. Fail there and we fail utterly. Upon the Shipping Board has devolved the responsibility of supplying this need, and supplying it under the most extraordinary conditions that ever existed,—supplying it at the most crucial period of the war's history, at a time when every other industry is being taxed to its utmost capacity in the matter of materials and labor to provide war necessities.

Handicaps

The handicaps have been many. We were not a maritime nation. Our flag had almost vanished from the seas, and with the exception of a few widely scattered shipyards, merchant marine construction had almost become a lost art with us. Then came this sudden call to outdo the rest of the world in the upbuilding of a merchant marine; a call coming at a moment when the Navy was undergoing the greatest expansion in its history—when most, if not all, of the established yards were feverishly engaged in rush construction on dreadnaughts, destroyers, submarines, fuel ships, tenders and other auxiliary craft, and when munition makers were absorbing that part of skilled labor which had not been called to Government navy yards or private shipbuilding plants. So it was a case of not only working from the ground up, but of first securing the ground upon which to make a start, some of it, marsh land, which had to be filled in before launching ways could be laid.

When we took hold of this job of shipbuilding, we found there was no shipyard in existence with which we could place an order. The old yards, with their trained force of shipbuilders, were filled to capacity. Seventy percent of their space was taken by the enlarged naval program. The remainder of the space was taken by the orders which had been placed by American owners, and by foreign owners, who, pressed for more ships, had filled the yards of America to overflowing.

Creating a New Industry

We were faced with the necessity of creating an entirely new industry. We had to establish the yards first, get the shipbuilders to take charge of them, and train the men to build the ships. There were 37 steel shipyards in America at the time of our entrance into war. We have located 81 additional steel and wood yards, while 18 other yards have been expanded. We are building in the new and expanded steel yards 235 new steel shipways, or 26 more than at present exist in all of the steel shipyards of England. The new industry we have created will make America the greatest maritime nation in the history of the world.

Struggling against something that cannot be avoided is more baffling than struggling against something that can be. You can appeal to striking men to go back to work, but you can make no appeal against zero weather. We did what we could. We told the new shipyards to go ahead and use dynamite in locating their pilings. The men in those yards fought the bitter winter. They had the same spirit, and demonstrated the same pluck and unselfishness as the men in the trenches. And they have virtually completed the job of building America's new shipyards—the new yards that will make us the greatest shipbuilding nation.

Shipbuilding Records Established

It has been an uphill struggle, but we have had our moments of elation when we have felt that we are making progress. The record made by the Skinner & Eddy Company of Seattle is a case in point. That company laid the keel for an 8,800-ton vessel, which was launched in 64 days. She was delivered to the Fleet Corporation on January 5 and started on the first voyage on January 14. This record accomplishment shows what can be done in live, wide-awake efficient American shipyards.

Then a few days ago we received a telegram from the Moore Shipbuilding Company of Oakland, Cal., announcing the successful launching of one of their large vessels. Twenty minutes later we received another telegram from the same company announcing the launching of a second ship of the same type, and forty minutes afterward a third telegram saying that a third vessel of similar character had gone overboard. This was the record of one American shipyard. The launching of three 9,400-ton vessels in a single afternoon—an accomplishment which I believe is unrivaled in the world's annals of shipbuilding.

The total amount of our steel construction on March 1 was 8,205,708 deadweight tons. This is made up of 5,160,300 deadweight tons under contract with the Emergency Fleet Corporation, and 3,045,408 deadweight tons of requisition vessels.

Progress of the Shipbuilding Programme

Of this total steel construction, 2,121,568 deadweight tons, or approximately 28 percent, has been completed. That means that in addition to the building of our big new yards we have also been building ships. That is, the program for steel ships has advanced 28 percent toward completion. Of the amount of steel ships under contract and under requisition, 655,456 deadweight tons, or approximately 8 percent, were actually completed and in service on March 1 of this year, nearly a month ago. This amount of floating tonnage exceeds our total output in 1916, including steel, wooden and sailing vessels, by approximately 50 percent.

Notwithstanding the difficulties of organization, the handicaps of bad weather conditions, transportation em-

*From an address before the National Marine League, New York, March 26.

†Chairman of the Shipping Board.

bargoes and railroad congestion, nearly as much tonnage has been constructed in American waters in the past three months as by all the other maritime nations of the world combined.

We have had to build up a tremendous administrative organization, with expert naval architects, expert traffic and operating heads, and at a time when the demand for such talent greatly exceeded the supply. We have had to negotiate for neutral tonnage. We have had to requisition and provide for the operation of the entire existing American merchant marine; we have had also to provide skilled supervision for the repairs of interned German ships which were seized.

The Germans thought that by crippling their own vessels in American waters they would be able to prevent us from using them. American ingenuity and resourcefulness gave the answer by restoring these vessels to efficiency. With the expenditure of a little less than $8,000,000 (£1,650,000) we have succeeded in placing in our war service and in the service of the Allies 112 first-class German and Austrian vessels representing a carrying capacity of nearly 800,000 deadweight tons.

At the outset the 37 old steel yards began increasing their capacity until they now have 195 ways as against 162 eight months ago. Other parts of their plants have increased proportionately. We then made provision for additional new steel yards, some of which have been given financial assistance by the Emergency Fleet Corporation. Thirty additional new steel shipyards are thus being erected, with a total of 203 shipbuilding ways. Thus we now have in the aggregate 67 steel shipyards either wholly or partly engaged in Fleet Corporation work. These yards will have a total of 398 steel building ways. Of these, 35 yards with 258 ways, are on the Atlantic and Gulf Coast; 19 yards with 6 ways are on the Pacific, while 13 yards with 74 ways are on the Great Lakes.

Wooden Shipbuilding

Our program for building wooden ships has been beset with many difficulties and handicaps which could not well be foreseen. A year ago, wooden shipbuilding in the United States was almost a lost art. We found 24 old wooden shipyards, with 73 ship ways. The capacity for wooden shipbuilding has been increased until we now have 81 wooden shipbuilding yards, with 332 ways completed or nearing completion.

Assuming that these ways will each produce two standard ships per year we should turn out about 2,300,000 deadweight tons of wooden ships annually. These 332 wooden shipbuilding ways, now nearing completion, added to our 398 steel building ways, will give us a total of 730 berths upon which to build steel and wooden vessels. When you consider that we had only 162 steel building ways a few months ago and 73 wooden shipbuilding ways —a total of 235—an increase is shown of 495 wooden and steel berths on which we can build ships.

With our total of 730 wood and steel ways, we will have 521 more berths than Sir Eric Geddes in his recent speech stated England has at the present time.

From the transportation standpoint, we must expect absolute freedom in the movement of our materials; otherwise the speeding up of manufacture is wasted, and consequent delays in finished ships will result. We look to the Railroad Administration with full confidence that they will supply our needs in this respect.

Turbine and Engine Manufacture

The situation giving us the most concern is the completion of turbines and engines. The very rapid expansion of the shipbuilding program caught the turbine and engine manufacturers totally unprepared. Special tools of all kinds were required for the engine builders' shops, and these tools had to be secured from manufacturing shops already overcrowded with war orders. In addition to this, the severe weather and the transportation tie-up seriously delayed the construction of some of our largest turbine building plants. We anticipated delay during the earlier months for lack of the turbines and engines, but expect to make up for the early shortage.

The proposal to build ships of concrete was first regarded as a fascinating absurdity. On March 14 there was launched from the yards of the San Francisco Company the first concrete steamship, a vessel which the builders christened *Faith*. We hope she will exemplify her name.

Labor—Our Strong Right Arm!

Now as to labor—Our strong right arm! There has been much talk of conscripting labor, of forcing it into shipyards as our soldiers have been brought into the camps. I wish to put myself on record as being opposed to the conscription of labor. I do not believe conscription necessary, for I believe labor itself will produce conditions which will render idle all thought of conscripting workmen. The vast majority of our workmen are men of intelligence, and when they come to a full realization of the fact that any defection on their part now will not only imperil the nation, but will injure their fellow workers in almost every field of industrial activity, I feel sure they will respond to all demands made upon them. Unless they fully do their part, their brothers will suffer.

It would be useless to manufacture material and supplies and pile up the products on the wharves if there are no ships to transport them. So, unless our ship workers do their best, other industries must slow down or halt completely, with the result that thousands of workers throughout the country will suffer for lack of employment.

I believe that labor has begun to realize that fact, but I want to drive it home to them; for there are some, I regret to say, who do not yet sense their responsibility. There are many who are not working to their full capacity. There are many who, because of the high wages they are earning, are prone to take too many holidays. Labor generally throughout our shipyards is to-day receiving the highest rate of wages ever paid for similar work in the history of the world. The additional cost of our ships, due to increased wages in shipyards covering the programme we have mapped out, will be in excess of $300,000,000 (£61,500,000). We expect, and we have a right to expect; the country has a right to expect, that labor will render for this increase of wages a corresponding increase in production—that is the output of ships.

Inefficient Shipyard Owners

There have been inefficient shipyard owners, as well as inefficient workmen. Where there is an inefficient owner, who does not understand the viewpoint of labor and who thinks only of his profits, labor has a right to complain. We intend to know what the costs and the profits are in every yard. We feel that the public is entitled to this information.

We have felt that it was our duty to see to it that the problem of housing the workmen in these vast new plants we have been creating was solved with care. The cost-plus system has been banned by Congress in the housing operations, because Congress itself, as well as the rest of us, have felt that there should be a greater check, not

merely upon profits, but upon the actual cost of all work done for the Government.

Training Workmen

The new yards have been established, wherever possible, away from the congested districts, and while this was necessary, it brought with it the problem of transportation, as well as of housing. We are arranging now for proper transportation, as well as for proper housing.

Training of new workmen for the yards has, in itself, proved a difficult task, but we are accomplishing it. We have established a large training school at Newport News to which 247 skilled mechanics, selected from 22 yards, have been detailed for a six weeks' course of intensive training to fit them as instructors for recruits brought into the various shipyards. Our latest report shows that 115 of these have completed the course and have been sent out as instructors. These men represent 16 trades. The men who are taking this instruction course will be capable of training an industrial army of 37,000 men. A department of training electric welders has also been established.

We have recruited a volunteer force of 250,000 highly skilled mechanics who have, with a patriotism that has made us all proud, agreed to hold themselves in readiness for our call. These men are being held in reserve in their present employment until such time as in the development of our yards the demand arises for their services.

Government Assembling Yards

In referring to what have been popularly termed our three fabricating shipyards, these assembling yards, with their 50 ways at Hog Island, 28 at Newark Bay, and 12 at Bristol, will, when they are in full operation, produce in a single year more ships than England, the greatest maritime nation of the world, has ever been able to turn out in the same length of time. Already at the yards of the Submarine Boat Company at Newark Bay, 15 keels have been laid, and 13 more will be put down as soon as the remaining ways, now in course of construction, are completed. By the time the last way is finished the vessel on the first way will be well on towards completion; and as soon as it is slipped into the water another keel will be laid in its place, and we will thus have a continuous series of vessels dropping into the water from this yard at the rate of two a week. Even greater tonnage will be produced at Hog Island, with its larger number of ways and the bigger type of vessels which are being constructed there.

When the high point in the curve of production finally is reached, and the magnitude of America's shipbuilding program is realized it will be a continuous performance of production and launching. There is no doubt but that we are destined to be one of the leading shipbuilding nations in the world.

Our Future Position

We will have the largest number of shipyards, the materials and the labor and when our shipbuilding plants are completed and are well organized on sound business lines so as to produce ships cheaply and rapidly, we will not only produce sufficient ships to become the leader in the commerce of the world by furnishing transportation at reasonable rates, thereby performing a service to the rest of the world, but we will build ships in such large numbers and at such fair prices that we will become the mecca of the shipbuilding trade of the world.

I have outlined the entire situation—in utmost frankness—concealing nothing, for we have nothing to conceal. Shipping is the essence of the struggle in which the world is now engaged—the central beam in the whole war structure. If that fails, all else fails. We are engaged in a race with the submarine. We, of the Shipping Board, are alive to the needs of the situation. The whole Government in Washington is alive to it, and there is complete coöperation to bring success in this greatest task to which America has set herself.

Standard Ships and Engines

THE Shipping and Shipbuilding Industries Committee of Great Britain has submitted its report on standardization, from which the following is taken:

Standard vessels and standard engines have been designed and are being built by a large number of firms, and the experience gained so far indicates that under normal conditions successful results might be achieved on similar lines. It should, however, be borne in mind that after the war efforts at increased standardization will rest with individual builders, and not with the Government. Standardization had been carried to considerable lengths before the war in details of outfit, and even to the extent of building complete standard designed vessels. Generally, however, standardization had been carried out works by works, and naturally in ordinary cargo boats alone. As in the case of the hulls of cargo vessels, so with marine engines, a considerable amount of standardization has been effected within the works of individual firms building marine engines, and we learn from the evidence of one of the witnesses that an effort is being made further to standardize marine engines of the reciprocating type for cargo vessels. This standardization has taken the form of a guidance specification, and is being drawn up under the auspices of the North-East Coast Institution of Engineers and Shipbuilders. In any type of engine such as is adopted for the plain cargo boat, where the general design is similar, differences being chiefly of detail, the universal use of such a specification should tend to an increase and cheapening of production.

In its recommendations the committee says:

"We view any movement towards standardization with satisfaction, and we are of opinion that further effort should be made to secure progressive standardization in all directions. We are aware of the very valuable work which has been done by the Engineering Standards Committee for the benefit of shipbuilding and marine engineering, in which work shipbuilders and engineers have taken a large part, and we therefore recommend that the Government suggest to shipowners, shipbuilders and marine engineers the desirability of forming a joint committee under the Engineering Standards Committee to consider these proposals. Shipbuilders and marine engineers who gave evidence before us considered that the question of increased standardization of production depended largely upon shipowners and their marine superintendents, and that it had not hitherto been practicable to carry it so far as it could have been had shipowners and their technical advisers been prepared to forego insistence on their own ideas in general design and details. It is for this reason that we recommend that shipowners (or their representatives) be joined with shipbuilders and marine engineers on the above Standards Committee. We recognize, however, that even so far as cargo-carrying vessels are concerned the extent of standardization as to dimensions and general design must necessarily be limited in ordinary peace times by difference of the draft of water at various ports, variations in the methods of loading and discharging cargo, the nature of the cargo itself, speed requirements, etc."

How Can We Build More Ships?*

Government Agencies and Shipbuilders Must Work Hand in Hand—Sympathetic Relations Necessary

BY JOSEPH W. POWELL†

IN 1914, the year that the war broke out, the entire production of ships in this country was no greater than will be turned out and delivered to the Shipping Board in this present month of April. It was in 1916 that the demand for tonnage really began to be acute, and when the growth of shipyards and shipbuilding really commenced. The year before, in 1915, we had finished something like a half million tons. In 1916 we increased the production to about three-quarters of a million tons, and in this last year, 1917, the total production was about a million and a quarter tons. Those of us who have studied the proposition carefully believe that during the present year, if things do not break too badly, the industry may turn out three million deadweight tons of ships. No nation has ever yet succeeded in adding as much as two million tons in one year to its previous high-water mark of production. In December last the five yards of the Bethlehem Shipbuilding Corporation had some 27,000 employees engaged in shipbuilding. This number has increased, until to-day we have about 47,000, and if we are able to maintain our rate of increase we figure that by the middle of December we will have about 60,000 men. In December our rivet driving, which is more or less a barometer of production, ran about 900,000 of rivets a week. For the last two weeks, of which I have record, we have run about 1,400,000 rivets. Put in terms of ships, this means two big merchant ships a week, or something over one hundred in the course of a year. Put in tons of ships, if these were all on merchant tonnage it would mean in the neighborhood of 900,000 to 1,000,000 tons deadweight of merchant shipping. Of course, the navy has absorbed in the neighborhood of half of our productive force for its work, and most of the other old line shipyards are equally giving up to that branch of the service an even larger proportion of their capacity. So that the large demand for new merchant tonnage brought about by the war must be handled to a great extent by the newer yards and the yards that are made up of people who are largely new to shipbuilding.

Shipbuilding Controlled by Government

To-day shipping is a controlled industry. The materials that go to make up the ships are allotted to us by the War Industries Board, and the wages that we pay our men and the conditions under which they work are prescribed by the United States Wage Adjustment Board. The prices that we receive for our ships are set by the Government, because all our work is for one department or another of the Government. Our transportation, of course, is subject to the Government's regulations for the handling of the railroads, and financing is possible at this time, so that anyone that wants money must call on the Government for their needs. The net result of all of these items is that there alone remains to the shipyard that vitally important function of management without which everything else means chaos.

But we are in the position where each of these various Government activities must function together with our management or shipbuilding will fall down. If transportation fails again, as it failed in January and February, if the control of our labor is not properly handled, and if the materials are not properly allocated, then the shipbuilder cannot hope to make good on the programme that he has undertaken. We, therefore, have the curious anomaly of a situation where the Government, in crying need of ships, controls in a vital way the various items that are essential in its production, and where none the less the shipbuilder who has to be called on to build ships must do his part or we cannot hope for a successful outcome of this war.

It is, therefore, clear that the one answer to the question, how can we build more ships in the next six months? is not far to seek. The most essential and most vital thing at the present time is to establish and maintain the closest of relations between the various Government agencies controlling the vital features essential to the carrying out of our work and the shipbuilders. If we cannot have this close association and if we cannot have a thoroughly sympathetic relation with Washington and the powers that be there we cannot hope for the best results.

Close Co-operation Between Government and Shipbuilders Essential

It is primarily at this time a necessity that those in charge at Washington should recognize this absolutely essential feature, that the shipbuilding industry should be called into conference on all occasions, and that as far as possible the practical experience of the men who have built ships for many years shall be used to the limit in the prevention of mistakes at the source, that will surely show in the output that can be expected from the yards. There has been a very considerable advance made in this direction in the last few months. Mr. Piez, vice-president and general manager of the Emergency Fleet Corporation, sits practically every two weeks with a committee of shipbuilders, and has shown a thorough appreciation of the necessity for knowing the troubles that come to our business, first hand.

It is rather unfortunate that in a large and newly made organization such as the Emergency Fleet Corporation there are so many men in subordinate positions who have been clothed with no inconsiderable authority and who have not yet appreciated that point of view, and it is going to be one of the most difficult things that confronts us at this time to make that big organization into one that will function as those at its head desire, and as those of us who work with it appreciate it must function if we are to produce results.

The question of financing is one that is touching practically every shipyard to-day, as this business of shipbuilding expands. The amount of money that is soaked up in carrying on the business is something that no one who has not taken part in a big business expansion can appreciate.

I find in talking to the various heads of the different shipyards that the experience is almost universal. The question of their bank balances is becoming more and more a vital one. A great load could be taken off from their shoulders by the Government by some system of financing that would relieve them from this portion of their business burden.

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* From an address before the Chamber of Commerce of the United States, Chicago, April 11.

† Vice-president, Bethlehem Shipbuilding Corporation.

In every shipbuilding community there are so many things that a Chamber of Commerce can do that will really help the shipbuilder that it is hard to list them in a few minutes. The question of housing, the question of transportation, the question of men, material and equipment are all questions with which the chamber of commerce is eminently fitted to deal. The question of showing the workmen that they have been set apart for a wonderful task at this time is one that can be carried on by this body with, I believe, the greatest good to shipbuilding as a whole.

I have maintained for many months that we must find some way to reach the men in the community through the women and children. I believe the organizations of the women and the organizations of the children and their instruction as to what this war means to them, can be carried back through the family to the workman in a way that will produce results almost beyond our expectations.

Work of Business Organizations Must Be Systematized

Efforts by the Chamber of Commerce must be systematized. We have had one sample only recently where almost hundreds of well-meaning citizens have nearly swamped the management of one of our plants in their endeavors to help in the housing proposition. If each local Chamber of Commerce would organize a committee to take up all the multitude of questions in which the shipyards can be aided and should arrange for meetings at stated periods with the shipbuilding management, the labor of the details can be taken off from the management, and at the same time the forces of the community can be brought together in orderly array to the help of the shipbuilders.

Physically our industry is quite prepared for a greatly increased shipbuilding programme. The labor is available. Its absorption into the industry and its training is going on at a very rapid rate.

The material situation, which is now becoming seriously menacing, is one which, if properly handled from Washington, can be straightened out, because sufficient material is available to provide us with what we need for our work. Fuel and transportation are also in hand, if priority to shipbuilding is given.

The plant management and the Government are equally anxious to perform, but there is still a great deal that needs to be done to assure that harmonious inter-relation without which great efforts can be very futilely expended.

Financial Assistance a Vital Question

Financial assistance is going to become increasingly a vital question as the volume of work becomes larger and larger, and, lastly, this community effort about which I have spoken is necessary to build up the spirit of our workmen to the point of view that will help more than anything else to produce the quantity of ships that we must have to do our part.

The time has come to cut out criticism, recriminations and bickering. For the shipbuilder to accuse the Government of not doing its part is not going to build ships. Neither is it going to build any ships for the Government to accuse the shipbuilder of falling down.

We know the Government is earnest. We know the people with whom we deal are as earnest in this matter and as fully alive to the necessities as any men can be. The shipbuilders are equally alive to the essentials of the situation. But to produce results we have got to get together and do the work. It is going to be this pulling together that will produce the volume of ships that we must have to carry on our part in the war.

The Shipyard Labor Problem*

BY MEYER BLOOMFIELD†

I HAVE just come from a tour of all the shipyards of the Pacific Coast, from Los Angeles to Seattle, having not only spent hours in the yards but days in conference with citizens' committees, the different Chambers of Commerce, the different Chamber committees and the representative of all the shipyards in every city, the bankers, shipbuilders and others interested in this one supreme problem of the present hour. The Pacific Coast is building ships fast and well. The most inspiring fact which I came upon in the entire visit is the spirit of labor on the Pacific Coast.

I have a mass of letters written to me while I was on the Pacific Coast by the workmen. The burden of their complaint is, "We have not enough work to do." There has been some delay in material, perhaps; a turbine held up on the road; material flagged somewhere and perhaps forgotten. The men, apparently, from all the evidence, want not only to do their bit, but, as Mr. Hurley recently put it, "do their all."

In October, when we began to keep records of the number of men employed in our shipyards, there were 102,000 employees. On April 8 there were 270,000 employed in the shipyards of this country. What the weather did to us in the East last winter can best be seen by the fact that the daily attendance in many of the Delaware River shipyards fell off to 50 percent. On the Atlantic Coast, from last November to date, and on the Pacific Coast, the daily attendance has been around 90 percent.

By centralizing all shipyard employment in Seattle—by agreement among the shipbuilders to use a public labor exchange, where craftsmen do the selecting of men for the shipyards—the turnover of labor in the shipyards there has dropped enormously. The waste of time in looking for a job or in going from gate to gate has been eliminated. Only two of the yards that I saw on the Pacific Coast could be spoken of as old yards, and yet they have multiplied their ways from a few to many so that they will turn out 400 ships on the Coast. I have seen shipyards on which the production will be 40,000 tons per way per year. That is an efficiency that has never been reached in the shipbuilding history of the world. They are doing it now. They are also doing it in some of the yards on the Atlantic Coast.

What is doing it? It is honest, frank, unqualified co-operation between the management and the men. When men have to wait for material or for tools or for air power, that is a problem for the management to solve, and the managers are trying to solve it better and better. But when men skulk and don't do their bit, everybody must take a hand in the discipline of these men, because they are committing a crime against the country and not against the shipbuilder himself. Every shipyard worker is now working for one employer—that is the United States Government. And this Government expects humane treatment, fair play and recognition of manhood in foremen, managers, riveter and heater boy. The management and the men have come to the consciousness that they are really working for themselves; they are working for their Government, and their Government expects 100 percent loyalty, 100 percent energy, 100 percent intelligence and 100 percent co-operation.

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* From an address before the Chamber of Commerce of the United States, Chicago, April 11.

† Industrial Service Department, United States Shipping Board Emergency Fleet Corporation.

Housing Our Shipyard Workers

**Shipbuilding Delayed by Lack of Housing Facilities—
Problem Involves Transportation of Shipyard Workers**

BY WALDON FAWCETT

SPEED in building merchant ships in the United States will be directly dependent upon the provisions of adequate living quarters for the shipyard workers. Recognition of this fact is responsible for the energy with which the housing problem, so called, has been attacked by the United States Shipping Board Emergency Fleet Corporation. It is, in effect, the mainspring of the project which aims to create, by the late autumn of 1918, residential communities at eleven or more shipbuilding centers where operations have been handicappd, if not definitely restricted, by inability to billet shipbuilding artisans on the communities.

It is not too much to say that the success of the U. S. Shipyard Volunteers' movement and the solution of some of the most difficult labor problems of the shipbuilders are directly dependent upon the execution of the housing programme, formally sanctioned in April by the Congress of the United States. This is no mere adventure in industrial community development, with the object of cultivating contentment among the shipyard operatives (although that is an incidental consideration), but is an important and imperative feature of the broad, constructive plan. By the summer of 1918 some of the most efficient shipbuilding plants will have reached the point where it will be impracticable for them to take on additional employees, however sorely needed, unless housing facilities for the newcomers shall have been provided in the meantime.

Scope of the Housing Department

The lately created housing department of the Emergency Fleet Corporation operates under the provisions of a very comprehensive special statute enacted by Congress and which authorizes the Fleet Corporation to not only acquire land and buildings, but likewise to sell such real estate. This latter authorization is important, because it is the intention of the Fleet Corporation, in so far as possible, to induce the ship workers to purchase, by instalments in lieu of rent or otherwise, the dwellings provided for their benefit. It is possible that there may be a factor of discouragement to this plan in the circumstance that high material prices which will cause the standardized four-, five- and six-room houses to cost more than had been anticipated, but, inasmuch as rentals will likewise have to be based upon these higher costs, it is hoped that a large proportion of the married men can be induced to own their own homes, with all the guarantee of permanency which such acquisition carries.

The special legislation under which the Emergency Fleet Corporation has undertaken its housing project places at the disposal of the Corporation for this operation the aggregate sum of $50,000,000 (£10,250,000). There is conferred, incident to the other powers bestowed, autocratic authority to requisition existing buildings and property adjacent to the shipyards suitable for housing purposes, but it is the present intention of the Fleet Corporation to commandeer dwellings only under what might be accounted exceptional circumstances. For various obvious reasons, it is accounted preferable to provide the shipyard operatives with new modern dwellings, designed as a result of a close study of the needs of the average family in the industrial environment involved and with each residence made a part of a harmonious community development that will in due course encompass recreation centers and other features of twentieth century urban life.

Basis of the Housing Contracts

For all the latitude given to the Emergency Fleet Corporation with respect to the construction of habitations for ship workers, the law does impose certain limitations with respect to entry into any contract providing for compensation to a contractor on the basis of cost of construction plus a percentage thereof for profit. As a result, perhaps, of these limitations, the housing contracts of the Fleet Corporation are on what is commonly known as the fee basis or commission basis, rather than upon the cost-plus plan, as it is usually applied. In erecting homes for ship workers the private contractor furnishes contract equipment and hires the labor, but Uncle Sam pays the labor costs, as well as material costs, and pays to the contractor a fee that does not increase pro rata with the total outlay on the project. This latter plan was, when followed in the construction of army camps and cantonments, objected to as offering a temptation for the inflation of costs, and consequently there were in Congress expressions of disapproval upon this plan as a working arrangement for housing construction at the shipyards.

Passenger Transportation Involved

When it was announced before the middle of April that estimates had been secured on the construction of 1,000 houses at Camden, N. J., and 1,600 houses at Hog Island, the indication of progress was gratifying to persons who realized that the preliminaries of this housing responsibility involve something more than mere approval of architectural designs. As an indication of the complex character of the problems grouped under the head of housing, it may be mentioned that at every scene of housing operations it has been necessary to make very thorough investigations of the passenger transportation problems affecting the ship workers at the different plants. This investigative work which has resulted in many instances in the re-routing of railroad trains or electric cars or the rearrangement of schedules and improvement of transportation service has covered Hog Island, Camden, Gloucester, Newark Bay district, Staten Island, Elizabeth, Savannah, Ga., Sparrow's Point, Baltimore, Portsmouth, N. H.; Bath, Maine; Quincy, Mass.; Groton, Conn.; Newport News, Va.; Port Jefferson, Newburgh, N. Y.; Chester, Wilmington and Bristol, Pa.

The execution of the housing programme is to be administered from Washington, where, as an integral of the central office organization of the Emergency Fleet Corporation, there has been created at 612 F street, N. W., a housing department. The housing department is essentially a section of the national service division of the corporation, which handles all welfare and industrial service work, and J. Rogers Flannery takes on the title of director

of housing in addition to that of manager of the national service division. Within the housing department a complete organization is being created, and there is more or less co-operative work. For example, in studying the problems of passenger movement affecting shipyard workers, the housing department has had the assistance of the transportation division of the Fleet Corporation, whereas Director of Production Robert Kohn, of the housing department, has in the selection of architectural designs for ship workers' homes had the benefit of the judgment of an advisory board of architects.

Design of Houses Not Universally Standardized

With the Emergency Fleet Corporation so largely committed in its ship construction programme to standardization of design, it is interesting to observe that in disposing of the housing problem this principle will not be universally adhered to. That is to say, while standardization of architectural design will prevail to a considerable extent in each shipyard community, the various communities are to be indulged in their individual or distinctive tastes with respect to forms of construction. Thus we will find at some yards brick dwellings exclusively (though this construction is in part dictated by fire regulations in cities such as Philadelphia), whereas at other yards frame residences will predominate, and at yet others stucco will prevail. In each instance an effort has been made to conform to local custom and the preferences of the main body of prospective occupants as disclosed by a first-hand investigation. On each project the aim will be to attain the same ideals of comfort and convenience regardless of the size of the house, so that each household in the community will enjoy an even equivalent in domestic advantages, even though some of the houses be half as large again as others.

Whereas the Emergency Fleet Corporation will incorporate as a feature of each extensive housing undertaking the erection of dormitories for the use of the single men in the shipbuilding community to be served, attention is to be concentrated upon the provision of individual family dwellings. Because of the uncertainties of the ultimate requirements of the military draft, added to the other considerations that have always obtained in connection with shipyard operation, shipbuilders are particularly anxious to recruit as large a proportion of the forces as possible from the older men—the married men. Temporary buildings, except under exceptional circumstances, are not favored. Experience has proven that even the unmarried ship workers resent assignment to habitations of a makeshift character. Discussing this phase of the subject recently, George J. Baldwin, chairman of the Board of the American International Shipbuilding Corporation, said: "When you come to get your expert men—your riveters and iron and steel men—they are not willing to live in what is virtually a poor barracks. They have to have better housing."

Shipbuilding Programme Retarded by Lack of Housing

The comment of Chairman Baldwin that his company would have to await housing facilities, provided through governmental aid, ere it could hope to attain its peak load of 29,000 employees in the yard, is paralleled by reports that have been sent to Washington from various private shipbuilding plants throughout the country. Months ago the management of the yard at Sparrow's Point reported that it was operating at much less than 50 percent of capacity because of inability to keep labor in the vicinity. Reports of similar tenor came from the Harlan & Hollingsworth and Pusey & Jones plants, and prediction was made from the Newport News yard that ship deliveries could be speeded up as much as six to eight months were adequate housing arrangements available to shelter a full complement of ship workers convenient to the scene of operations.

Lack of houses has been specifically blamed by some of the shipbuilders for the high "mortality" of labor, which has reached appalling proportions during the past year. The Bethlehem Steel Company reported that its yard could produce one and one-half ships per month additional if they had the operatives, but that workmen could not be held under conditions which necessitated residence in Baltimore with a trip of, say, an hour and a half duration each way, every day. The consequence was that this corporation had a labor turnover of approximately 11,000 men in eight months in order to maintain a force of 4,000 operatives. In reality, the record was even more discouraging than the above figures would indicate, because the company, in its effort to permanently increase its force, employed some 18,000 men, of which number about 11,000 were actually put to work, remaining on the job, at an average, for only a comparatively brief interval.

In the gratification in most quarters over the fact that the Emergency Fleet Corporation has definitely undertaken relief work in shipyard housing, there is no disposition to ignore or underestimate what various private shipbuilders have done in an attempt to solve the problem. Meyer Bloomfield, assistant to Manager Flannery, remarked on this score: "The shipbuilders have spent an enormous amount of time personally on these problems. Some of them have engaged men specially for the purpose of hunting up houses, negotiating rentals and making arrangements for houses; and in many instances those efforts came to naught."

Generous Co-operation of Private Shipbuilders

During the discussions of arrangements for housing some of the private shipbuilding interests have offered to contribute to a housing fund that would be made up mainly by governmental appropriation. For example, the Bath Iron Works, which requires 100 houses for skilled workers and 25 houses for salaried men, involving a total expenditure of $450,000 (£92,200), indicated at one time that it might be willing to contribute 10 percent. A tentative proposal from the Newport News Ship Building Company contemplated the donation of sites for 700 houses to cost $2,500 to $3,000 (£513 to £615) each. Various concerns have at one time or another put forward proposals looking to the payment of interest on a Government loan for housing purposes. In some instances guarantees for the ultimate return of the Government loan or a large part of it were contemplated, and in other cases no such assurance was forthcoming.

In the case of Government-owned shipyards, operating under agency contracts, the fact that the Government owns the housing of the machinery is taken as sufficient justification for governmental construction of housing for labor. This explains why it is possible to push with especial energy the housing operations at plants such as Hog Island, where it is expected that independent dwellings will have to be provided for approximately 12,000 men, allowing for the housing of 14,000 to 15,000 workers in Philadelphia and the accommodation of a maximum of 3,000 men in barracks or dormitories at Hog Island. Of course, there remains for adjustment in the case of Government-erected houses at Government-owned plants, just as with dwellings at private shipyards, the arrangements as to mortgages with reference to ship workers

who desire to purchase the properties they occupy. Such details have not been fully worked out, or, if worked out, are subject to revision, but the feeling seems to be that it will be necessary, in order to keep ship workers satisfied, to put on a blanket mortgage or to introduce the instrumentality of stock sales, so that no shipyard employee will hesitate to buy a home for fear of being tied to any company or any community by reason of ownership of a house that could not be easily sold.

Dwelling Construction at Hog Island

The ideas that have been entertained in official quarters with respect to housing arrangements at shipyards are perhaps best indicated by a brief resumé of the recommendations with respect to dwelling construction at Hog Island. The first recommendation was for two types of houses to be built in varying numbers. The first type was a semi-permanent frame, one-story cottage type in one-, two- and four-family units, to be built without cellar, equipped for stove heat, complete bath and kitchen plumbing, wall-board partitions and generally light construction. The second type house was similar to the design just mentioned, but provided with a partial cellar and furnace heat, and was available in a two-story as well as single-story design. A rental charge based upon 10 percent of the gross cost of the buildings and public utilities was suggested.

Pending a permanent disposition of the housing problem at Hog Island, a considerable part of the force has been housed in temporary barracks of the dormitory type —eight rooms to the barracks, each room with accommodations for 12 men. For these accommodations a uniform charge of 10 cents (0/5) per night is made. Gradually, sentiment with respect to the housing of shipyard workers seems to be crystallizing in favor of the standardized four-, five- and six-room houses, with no room smaller than 10 by 12 feet in size, such houses to cost, at a rough estimate, anywhere from $2,000 to $3,500 (£410 to £717), each according to local conditions, etc.

In working out the housing proposition, every attention is to be bestowed upon the experience of private shipbuilders, who have in the past acted in this matter on their own initiative. "Model houses" for shipyard workers, such as have been provided by the McDougal Duluth Shipbuilding Company and other concerns, are expected to afford ideas for the dwellings that will be sponsored by the Emergency Fleet Corporation.

New Type of Construction for Wooden Steamer Designed by Lee & Brinton, of Seattle

AT the yard of the Allen Shipbuilding Company, at Ballard, the keel has been recently laid for a wooden steamer of a special type of construction, to be built for the Emergency Fleet Corporation. The general arrangement of the vessel will be the same as that of the Ferris design, and the same propelling machinery will be used, although the vessel is slightly larger than the Ferris ship, with a length over all of 288 feet, molded beam 43 feet 8 inches, and molded depth 26 feet 4 inches, and having a deadweight carrying capacity of 3,650 tons.

Plans for the new vessel are being drawn by Lee & Brinton, naval architects, of Seattle, who are introducing a type of construction which they have heretofore used with success in small craft, and in which they are now adapting for use in vessels of the larger sizes.

The peculiarities of the construction consist in the method of building the frames, which are of the single-frame construction, as compared with the double-frame method ordinarily used in wooden shipbuilding. For the parallel mid-body, which is carried 45 percent of the length of the vessel, each set of frames is made up of only three pieces, consisting of a deep floor timber running in one piece from side to side of the vessel and connected to the two side timbers by a special method of bilge construction. The floor timber runs flat on top, and the dead rise is sawed out of the lower side. The turn of the bilge has a radius of 4 feet 6 inches, and the midship section approximates that of a steel steamer of the same size. Forward and aft the parallel mid-body the floor timbers start to rise and are cut at the centerline of the ship, while the side frames are slanted in towards the centerline and with the radius of the bilge gradually increasing so that a fair shipshape form of under-body is produced.

The advantages of this type of construction for rapid building are quite apparent, and it is claimed by the architects that the construction is stronger than the ordinary type. The plans have been approved and recommended by the surveyors for the American Bureau of Shipping, Lloyd's register, and the naval architects for the Shipping Board. The contract calls for delivery of the hull in six months' time.

Effect of Torpedo Explosions on the Structure of Merchant Ships

SOME time ago the Council of the Institution of Naval Architects appointed a committee "to inquire into the effects of explosions of mines and torpedoes on the structure of merchant ships." The committee was constituted as follows: S. W. Barnaby (chairman), Admiral Sir Henry Jackson, G.C.B., F.R.S.; *Professor Sir John Biles, D.Sc., LL.D.; W. H. Whiting, C.B.; A. E. Seaton, Professor T. B. Abell, M. Eng.; Professor J. J. Welch, M.Sc.; R. W. Dana, M.A., secretary.

Their first report is on cargo steamers, and the second on passenger steamers, and they were submitted in May, 1917. They were made available privately to shipbuilders and shipowners; but official sanction was given to their publication along with the annual report of the Council to this year's meeting of the institution. The report is as follows:

I.—Cargo Ships

Your committee have thought it desirable to issue a preliminary report containing suggestions for certain temporary war expedients which might be adopted at very little expense in the ordinary type of cargo vessel, and which they are of opinion would have the effect of greatly increasing their chances of safety after being mined or torpedoed, provided that only one main compartment is opened up to the sea.

The committee, having examined the information placed at their disposal by the Admiralty and the Board of Trade, are of opinion that the loss of many of these vessels has been due to three causes: (a) the existence of watertight doors low down in the bulkheads, which could not be closed after the explosion; (b) fractures of suction pipes in the attacked compartment, permitting water to flow into adjacent compartments; (c) the penetration of bulkheads adjacent to the attacked compartments by fragments of plating, frames, rivets, etc.

A large number of cargo vessels have four main holds and six bulkheads arranged as follows: No. 1, collision

*Sir John Biles has been absent owing to illness since the first meeting of the committee.

bulkhead; No. 2, between Nos. 1 and 2 holds; No. 3, at fore end of boiler room; No. 4, at aft end of engine room; No. 5, between Nos. 3 and 4 holds; No. 6, at after peak.

With fewer bulkheads than this the chances of keeping a vessel afloat are very much reduced.

Taking this six bulkhead arrangement as a typical case, the recommendations of the committee, as applied to cargo ships with six or more bulkheads, are as follows:

1. All existing watertight doors low down in main bulkheads should be closed up and so secured that they cannot be opened. If watertight doors are necessary, they should be fitted high up in the bulkhead.

This is particularly important when bunker coal is carried forward of the boiler room bulkhead, as a watertight door through which coal is being trimmed cannot be depended upon.

2. The watertight door to the shaft tunnel in the engine room bulkhead should be closed up and so secured that it cannot be opened, access to the tunnel being provided by means of a watertight trunk carried up to the bulkhead deck.

Cases have occurred when the engine room has been flooded too quickly to permit of the tunnel door being closed, with the result that considerable quantities of water have entered the after holds through the tunnel, which was not sufficiently watertight.

An explosion in one of the after holds would be likely to injure the tunnel, resulting in the flooding of the engine room and boiler room, unless the tunnel door is closed, as proposed.

3. The tunnel, or any other longitudinal passage below the waterline, should be thoroughly watertight.

4. Each suction pipe, where it enters the compartment from which it drains, should be provided with a screw-down non-return or other suitable valve, which can be worked from the bulkhead deck. These valves should be kept closed at all times, except when the pumps are in use.

5. The amount of injury which the bulkheads might receive from flying fragments will depend greatly on the nature and amount of cargo in the hold.

If the hold is well filled, the risk of injury is much less than when partly filled or empty. If the cargo is of a heavy nature the upper parts of the bulkheads will probably be exposed.

It is recommended that, wherever possible, the bulkheads should be protected temporarily by means of timber or other suitable material, forming a splinter screen. In some cases the cargo itself could be utilized for this purpose. The necessity for some protection of this sort is particularly great in the case of ships in ballast.

Very little time and money would be expended in giving these measures of protection to a large number of cargo vessels.

II.—Existing Large Mail and Passenger Vessels

These vessels, having more numerous bulkheads in proportion to their length than the ordinary cargo steamer already reported on, should be better able to withstand attack from mine or torpedo.

On the other hand, many mail and passenger steamers have watertight doors in the 'tween decks, giving communication through the watertight bulkheads between passenger and other spaces. They have also side scuttles for ventilating cabins, and numerous sanitary discharges very near the waterline. These are liable to be submerged and to admit water should the scuttles be open or the controlling valves to the baths, water closets, etc., be inefficient. This liability will be greater in the case of vessels having small initial stability or possessing longitudinal bulkheads, if damage occurs in way of such bulkheads. In some vessels also there are passages leading through bulkheads in the ship's hold to allow the firemen and greasers to gain their quarters without traversing any of the passenger decks. All these features have proved to be sources of danger.

Further, the hatchways in such vessels are relatively small and do not afford such instantaneous relief from air and gas pressure resulting from an explosion as in the case of the larger hatchways of cargo vessels. For this reason it is considered that bulkheads in the neighborhood of the explosion are more liable to distortion in mail and passenger vessels than in cargo ships, and that watertight doors on such bulkheads cannot be relied upon to close after an explosion. Devices for closing doors from the bridge are likely to fail, both by reason of the above-mentioned distortion and because of the probable destruction of the hydraulic or electric mains provided for the purpose in the region of the explosion.

In view of the foregoing, it is suggested that the following measures be adopted in existing vessels during the continuance of the war:

1. The disuse of all firemen's passages and the closing up of all doorways in bulkheads traversed by them when below the bulkhead deck, the firemen passing to and from their quarters by way of an upper deck, where a temporary screened passage could be provided if necessary.

2. All openings from the engine room into shaft tunnels to be abolished and access to tunnels provided through trunks abaft the engine room bulkhead: these trunks to be watertight to the bulkhead deck.

3. All watertight doors in transverse bulkheads throughout the machinery spaces to be closed and so secured that they cannot be opened, provision being made for efficient supervision in each separate compartment. If this is deemed impracticable in certain cases it is recommended that in such cases the doors on the level of the stokehold and engine room floors should be closed and others fitted as high up as possible on these bulkheads.

4. All watertight doors in transverse bulkheads on decks below the bulkhead deck to be closed and so secured that they cannot be opened, additional exits to the decks above being provided where necessary.

5. All side scuttles situated below the first deck above the bulkhead deck should be closed up and sealed. Special fan ventilation is to be provided if necessary for the cabins affected.

6. Each suction pipe, where it enters the compartment from which it drains, should be provided with a screw-down non-return or other suitable valve which can be worked from the bulkhead deck. These valves are to be kept closed except when the pumps are in use.

7. Where ventilation trunks, etc., pass through watertight bulkheads below the bulkhead deck, valves operated from above that deck should, in all cases, be fitted at the bulkheads, and if any trunk pierces the bulkhead at a low level it is strongly recommended that a new lead should be devised to carry it through the bulkhead at as high a level as possible.

8. Valves on all sanitary discharges at the ship's side should be such as will prevent water passing inboard through them when the vessel has considerable trim or list. These valves should be frequently examined and kept in good order.

9. Any ash or rubbish shoots, etc., having upper ends opening on decks below the bulkhead deck should be provided with watertight covers, and instructions should be issued to ensure that these covers are always in place when the shoots are not in use.

Build More Wooden Ships

**Plea for Continuation of Wooden Shipbuilding—
Foreign Countries Ready to Order Wooden Ships**

BY H. J. ROUNDY*

A RECENT resumé of shipbuilding in the United States for the year 1917, as published in a paper devoted, in part, to marine construction, contains the following remarkable statement:

"There followed the proposal to build a large number of wooden steamships in new yards constructed for the purpose. It did not meet with the approval of practical ship men.——," and later continues: "There was never any adequate reason for the wooden ship, because the labor and the material to make them were not available."

The above statements are quite erroneous and are misleading to both technical and non-technical people. The American public, from ideas obtained from newspaper articles of similar caliber to those above noted, are beginning to believe that our gigantic wooden shipbuilding programme has failed, and that immense amounts of money have been wasted in attempting to further this programme. To show that it is possible to avoid a useless expenditure of money in the outlay of these shipyards and consequent loss to the United States Government of just so much money, which is needed for the prosecution of the war, it is the intention of this article to attempt to rehabilitate the wooden shipbuilding programme in the minds of the people who are doubting and condemning.

It is not the intention of the article to claim that steel ships are inferior to wooden ships, or *vice versa,* or to show that wooden ships can even approximate the economy or efficiency of steel-hulled vessels. But it is the idea to show that wooden vessels have a fixed and certain place in the shipbuilding programme of the United States, and that it would be folly to rule the continuation of the construction of wooden vessels out of existence.

Practicability of Wooden Shipbuilding

Let us first discuss practicability, and at the start take into consideration the size of the majority of wooden ships we are at present building and compare them with some of their predecessors. The idea of impracticability seems to arise, in part, from the false notion that we are building ships far too large for wooden vessels, and that these wooden vessels, after being built, are short-lived. Let us reconsider some of the big wooden vessels of olden times.

First, there was the *Arabia,* of the Cunard Line, which was 285 feet long; the *Adriatic,* of the Collins Line, which was 351 feet long, and which, by the way, saw 42 years of service. Then there was the *Vanderbilt,* 331 feet long. This vessel was built in 1855, and in 1910 was still afloat at Gibraltar. The *Ontario,* which was 325 feet long, 43 feet beam, 29 feet depth, and which was the largest wooden screw steamer ever built, only ended her career when she was broken up at the age of 30 years in Boston. The size of the ships we are building range from 280 to 315 feet long, which is not excessive when compared to some of those above mentioned. There is no reason why some of our wooden ships will not last for 30 years, as well as our old-time ships, provided due care is used in their construction and in the selection of the timber. Even should they last but six months, they would surely pay for themselves, and the rankest kind of timber should keep from decay that long.

What Wooden Ships Have Done

We must remember that practically all the territory we now know of has been discovered with the aid of wooden ships; that a great proportion of the commerce of the world has been transported with wooden ships; that a great many wooden ships still are being used in transatlantic and coastwise trade. Because steel ships have supplanted wooden vessels almost entirely for transatlantic trade at present is no reason why wooden vessels should not supplement steel ships in transatlantic trade at the present time. Even though it be considered unwise to send these wooden vessels across the ocean, they would still have a very great field in performing the duties of coastwise steamers, thus releasing numbers of small steel vessels for foreign trade.

A noticeable trait of the American people is to decry any innovation. Wooden shipbuilding, as described and condemned in newspapers, magazines, congressional speeches, etc., is such an innovation. The American public are convinced that they are being deluded by false hopes of the ultimate success of the wooden ship. To offset this idea, let me state that the company with which the writer is at present connected has received numerous requests for plans, specifications, contracts, etc., from Norwegian, English, Italian and French owners. Were it not for Government stipulations, which forbid shipyards taking additional contracts while they are working on vessels for the Emergency Fleet Corporation, all the yards on the Gulf Coast would be overloaded with contracts for ships to be built for these foreign countries. This shows that countries that have had large merchant marines are not skeptical about buying wooden vessels.

It may be also stated that in one yard on the Gulf Coast two immense wooden steamers are being built for a line none other than the conservative Cunard Line. This yard could get contracts for a dozen more had they not turned over their plant for United States Government use. At another yard in the vicinity there are ten or twelve large wooden vessels being built for the Italian government. These countries realize the advantages of wooden ships. America apparently does not. We are building both steel and wooden ships, it is true, but while new contracts are almost daily being given out for steel bottoms, no attempt is made to give additional contracts for wooden vessels. After the war immense numbers of wooden ships will be built for foreign nations and the United States will get none. Foreign countries will be willing to build up their disorganized shipping with any kind of vessels, while the United States will be sticking exclusively to steel.

Ships, and More Ships, Wanted

Let us now discuss the "adequate reason" mentioned in the article above referred to. Curiously, it is answered later by this trite statement: "Ships, More Ships, and Still More Ships." Ships, we are told by the rulers of our nation, are as necessary as soldiers in winning this war. This statement would seem to be a reason for using

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anything that we can get on earth that would carry cargo or for using anything that we can get that will make something else that will carry cargo. We need the ships and we should be reasonable and use whatever it is possible to get that will serve our purpose. Let us draw a simile:

Suppose it were necessary immediately to construct two bridges across the East River in order that thousands of people on Long Island might be saved from some dire catastrophe. Suppose, also, there were only steel and steel workers enough to construct one bridge, and that there were wood and wood workers enough to construct the other bridge. What would you do? Would you condemn the wooden bridge, saying that it was impracticable, obsolete, would probably rot in twenty years? Would you also say: "No; let us wait until we get the additional steel and men to work the steel, which will be in six or eight months, as a few thousand lives more or less do not matter, but we surely ought not to allow our engineering progressiveness to be degraded"? No. The answer would be to build bridges out of any material, even straw, if we could get it to last long enough to relieve the situation in hand; but, at any rate, build bridges!

Utility and Economy of Wooden Ships

There are some points relative to the building of these wooden ships which newspapers and technical papers devoted fanatically to pure engineering subjects do not often discuss, viz.: the utility and economy. As to their utility, they can go anywhere that the steel ship can, and they have gone places where steel ships cannot and do not go. They can trade in the warm waters of the Gulf and the Mediterranean, or in the North Atlantic, as efficiently as steel vessels; and they can trade in the ice fields of the North where steel ships do not often go. Efficiency, in the case of the present war, is not merely dependent upon the amount of food and ammunition that can be stowed in one hull and sent across the Atlantic, but is really dependent only on the amount of food and munitions we can get across the ocean in a certain time. The amount of freight carried in a wooden ship of the same displacement as a steel ship is undoubtedly smaller; but there is no reason why enough wooden ships cannot be built to overbalance this difference. For the same amount of freight carried, the more ships we use, provided they are completely loaded, the less risk there is in their being molested on their passage. Hence, smaller ships mean smaller risks, smaller crews and no increase of cost.

In discussing the constructive economy, there are three features to be considered: First, relative cost; second, conservation of labor; and third, speed of construction.

Relative Cost

Taking first the relative cost, let us draw a few comparisons. In the following tabulations remember that the figures refer to deadweight tonnage, which is a principal factor in determining ship economy. The following figures comprise averages of all the steamships building in the United States at the end of December, 1917:

Type	Average Deadweight Tons	Average Cost Per Deadweight Ton
Composite	3,568	$133.97 (£27.56)
Steel	7,027	166.48 (£34.25)
Wood	3,752	139.69 (£28.74)

The above figures are for ships complete with engines and boilers. The United States Shipping Board is paying builders for the Ferris type vessel only, approximately $84.87 (£17.46) per deadweight ton. It will thus be seen that while the cost per ton of composite ships is the lowest, the entirely wooden ship is much lower than the entirely steel ship, the cost of a wooden ship per deadweight ton being nearly seventeen percent less than a steel ship per deadweight ton.

Conservation of Labor

Second, regarding conservation of labor. These new wood ships which are mentioned so disparagingly have taken practically no men from steel yards, leaving all these men to continue their work for the Government on steel ships. To stop the construction of wooden vessels would not increase the number of men in the steel yards by the addition of these wood workers, as these men are entirely unused to steel shipbuilding tools. The steel shipbuilding industry gets many recruits from boiler makers, steel bridge men and steel construction men. Wooden shipbuilding gets its recruits from house carpenters, timbermen and wooden bridge builders. There is a sharp, definite line drawn between the two classes of men, and releasing one from duty would not amplify the ranks of the other.

Speed of Construction

Third, let us consider the speed of construction. The following data have been taken from the statements of Chairman Hurley, of the United States Shipping Board, to the investigating Senate committee:

At the beginning of the year there were being constructed in the United States the following general classes of ships of the tonnage denoted:

Wooden ships	1,344,900 tons
Composite ships	207,000 tons
Steel ships	3,965,200 tons

This shows that 24 percent of the total tonnage of ships under construction was made up of the entirely wooden ships.

Reverting once more to the paragraph mentioning the new wooden yards, we have from Chairman Hurley a statement that this tonnage was being constructed in 72 wooden yards, 51 of which had been organized just for these contracts, and in 32 steel yards, 20 of which, also, were brand new. This indicates that 70.8 percent of the wooden shipyards were brand new, which would indicate that they should be further behind in their progress. Offsetting this, we have his statement that at the beginning of January the steel tonnage was 4 percent completed; composite tonnage, 20 percent and wood tonnage, 9 percent towards completion, showing that, despite the fact that ship carpenters were practically unobtainable and lumber was scarce, the wooden vessels were over twice as far towards completion as the steel ships. This much for the speed of construction.

Conclusions

We know how necessary it is that we have ships, ships of any class—wood, composite, concrete or steel. The above figures show that wooden ships in first cost are cheaper than steel, and are being constructed faster than steel, and that in their building we are dragging no one away from the construction of steel vessels. The obvious result would be to build more wooden ships.

Cries of conservation of timber are used in the effort to combat the wooden shipbuilding programme; but consider conservation in its true meaning. If we care to, we could take an accurate count of every board foot of timber on earth, but we cannot do the same with iron and steel. We do not know when steel or iron will give out, but we can figure when we will use up all of our timber. Should the Government so desire, it might foster tree farming as an agricultural science. There is no reason why we should ever be out of timber, provided it is used judiciously. Iron will, without a doubt, oxidize, and is lost forever, and we can make no new to compensate for its

loss. Timber should be conserved, but so should every other animal, vegetable or mineral which is valuable to mankind. It is not absolutely necessary to make ships out of the material specified by the United States Shipping Board. Columbus used no long-leaf yellow pine or Douglas fir. We are using in the construction of our wooden ships materials that twenty years ago were not ordinarily thought of for shipbuilding purposes, viz.: Red gum, Bois D'arc, etc. We are plentifully supplied with sweet gum, which could very easily take the place of yellow pine.

And there is another way of conserving timber, and that is to so design our vessels that the immense pieces of timber we are now using are not necessary. One way of overcoming this trouble is to use diagonal planking. This not only reduces the size of the timbers, but obviates the use of steel strapping, another commodity which is in great demand at present. We might also have a more efficient disposal of strength members in the ships by placing them where they will be of some use, rather than where they will take up room. We can also cut down the cost of our wooden vessels and add to their carrying capacity by placing engines aft; use less ornate furnishings in the accommodations, remembering that space in a freightship is the primary object, and not separate rooms for every man in the crew. The last way of cheapening the construction of wooden ships is to build them where the materials can be readily had, viz.: in the South and on the West Coast.

The Ship of the Future

Let us look at the ship of the future. Will she be wood, composite, concrete or steel? Undoubtedly, she will be steel or concrete, but it is not the ship of the future we are now worried about; what we are concerned with is the ship of the present. Why not use any material that will construct any object that will carry freight or troops across the ocean? Why not use the material that will build ships cheaper, faster and as serviceable, viz., wood? Our wooden shipyards in the United States will finish their contracts in September. Are these yards to keep going and continue to build ships for the United States, or will they just build ships for our English, French, Italian and Norwegian neighbors? Immense sums have been layed out in these yards. Why not give the United States the opportunity to increase its merchant marine tonnage by means of these yards? Why not keep going on with our old-new industry and build more wooden ships, at least until the war is won and American commerce is once more in the van?

First Motorship Fitted with Reduction Gears

The 3,500-ton motorship *James Timpson,* built by the G. M. Standifer Construction Corporation, Portland, Ore., is fitted with two 500-horsepower Winton Diesel engines equipped with reduction gears designed to give the vessel a speed of about eight miles an hour. The engines are of the six-cylinder type, designed to run at a normal speed of 325 revolutions a minute, while, by means of the reduction gears, the propellers turn at 100 revolutions per minute.

The vessel was built to the order of I. T. Williams & Son, New York, and is intended for the mahogany trade out of New York. She is 279 feet long, 44 feet molded beam and 25 feet molded depth.

An engineer who answered the question "What is a vacuum?" in an examination for a first-class certificate by "A vacuum is foul air which generally comes from the bilge," had run engines for sixteen years with great success, and no one could beat him in scraping a valve or keeping his engine in first-class shape.

How Local Business Organizations Can Help in Transportation of Shipyard Workers

Answering the question "What can the local business organizations do in helping provide adequate transportation for the shipworkers," Philip H. Gadsden, president of the Charleston Light and Power Company, one of the members of the National Committee on Public Utility Conditions, of the Chamber of Commerce of the United States, at its recent convention called for co-operation on the part of the public for the street car companies, a willingness to put up with inconveniences, less frequent service, so that men, effort, fuel, time and material be available for the special service of the Government.

In part, Mr. Gadsden said: "Everything possible should be done to accomplish a more even distribution of traffic and consequent improvement of service. To bring this about, some definite steps should be taken, and I would set forth my suggestions and recommendations in the following order:

"First—Deal with the street car problem in a spirit of co-operation and helpfulness. This includes consideration of an increase in the price of the commodity which the company produces and sells, viz., transportation.

"Second—That the street railways which are not provided with sufficient equipment and other facilities to properly handle present and prospective traffic make every effort to secure such equipment and facilities as far as will be practicable at the earliest possible date.

"Third—That the street railways put into effect everything that can be done to bring about improved efficiency and the conservation of materials and man power.

"Fourth—That the attention of the officials of industrial and governmental plants be attracted to the necessity of full co-operation by staggering the hours of employees so that the same number of cars and men can be used for several trips, instead of only one.

"Fifth—Attention of members of department stores and other commercial establishments should be called to this matter, in the hope that they will adopt such means as may be most efficient in their efforts to induce their patrons to co-operate in the movement to secure a more even distribution of traffic by advocating that women do their shopping in the morning and early hours of the afternoon. That the newspapers of the State shall join in the movement in order that the greatest publicity may be obtained.

"Sixth—That the hearty co-operation of the authorities in the various municipalities in the State be given to the movement; that the Boards of Trade and Chambers of Commerce give their assistance to accomplish the results sought.

"Seventh—That the skip-stop method of operation be adopted.

"Eighth—That the communities forego during the period of the war new pavements or repavements and other improvements which would require expenditures by the street railway company.

"From an extensive and intimate acquaintance with men engaged in the street car industry, I know I can promise their hearty co-operation in everything that will tend toward the upbuilding of the communities they serve, and their best and most loyal efforts to the strengthening of our country's arm in its present hour of need."

NEW PACIFIC COAST STEAM SCHOONERS

Designed by D. W. and R. Z. Dickie, San Francisco, Cal.

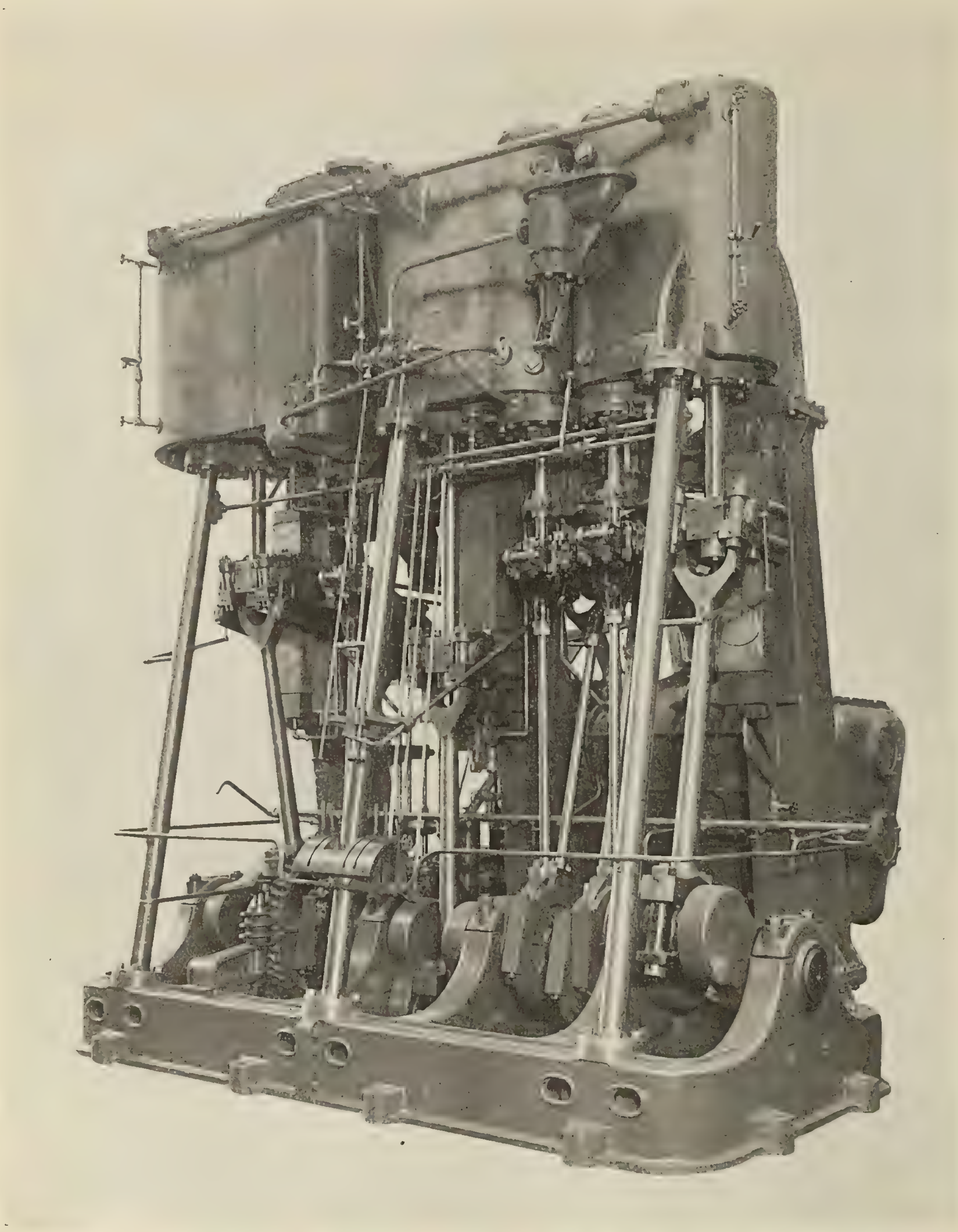

Fig. 1.—Triple Expansion Engine, Designed and Built by Main Street Iron Works, San Francisco, Cal.

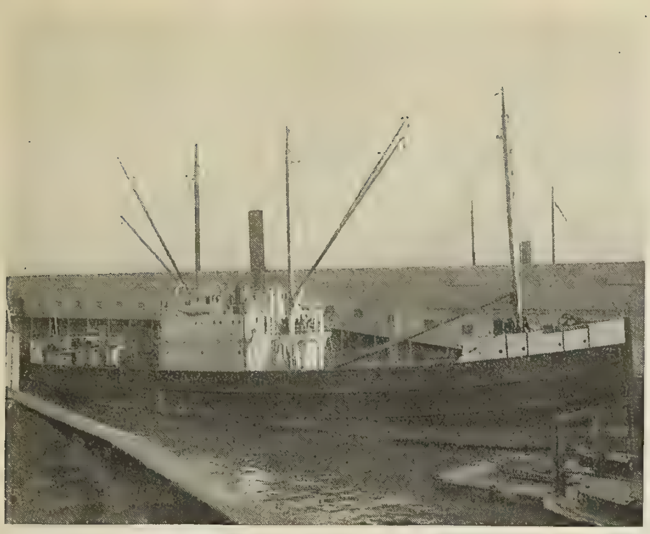

Fig. 2.—S. S. *Edna Christenson*

Fig. 3.—S. S. *Lucinda Hanify*

New Pacific Coast Steam Schooners

Wooden Lumber Carriers Designed by D. W. and R. Z. Dickie, Naval Architects, San Francisco, Cal.

TWO sister ships—the *Edna Christenson* and *Lucinda Hanify,* in which are embodied some of the latest developments in wooden lumber-carrying steam-schooner design, have recently been completed and subsequently sold to the French government.

These steamers are duplicates and the hulls were built to the order of Sudden & Christenson and the J. R. Hanify Company, under a labor contract with Charles Fulton, of Long Beach, Cal., and to plans by D. W. & R. Z. Dickie, of San Francisco, the design being worked up from the ideas of Mr. E. A. Christenson, president of the Sudden & Christenson Company, and the work done under the direct

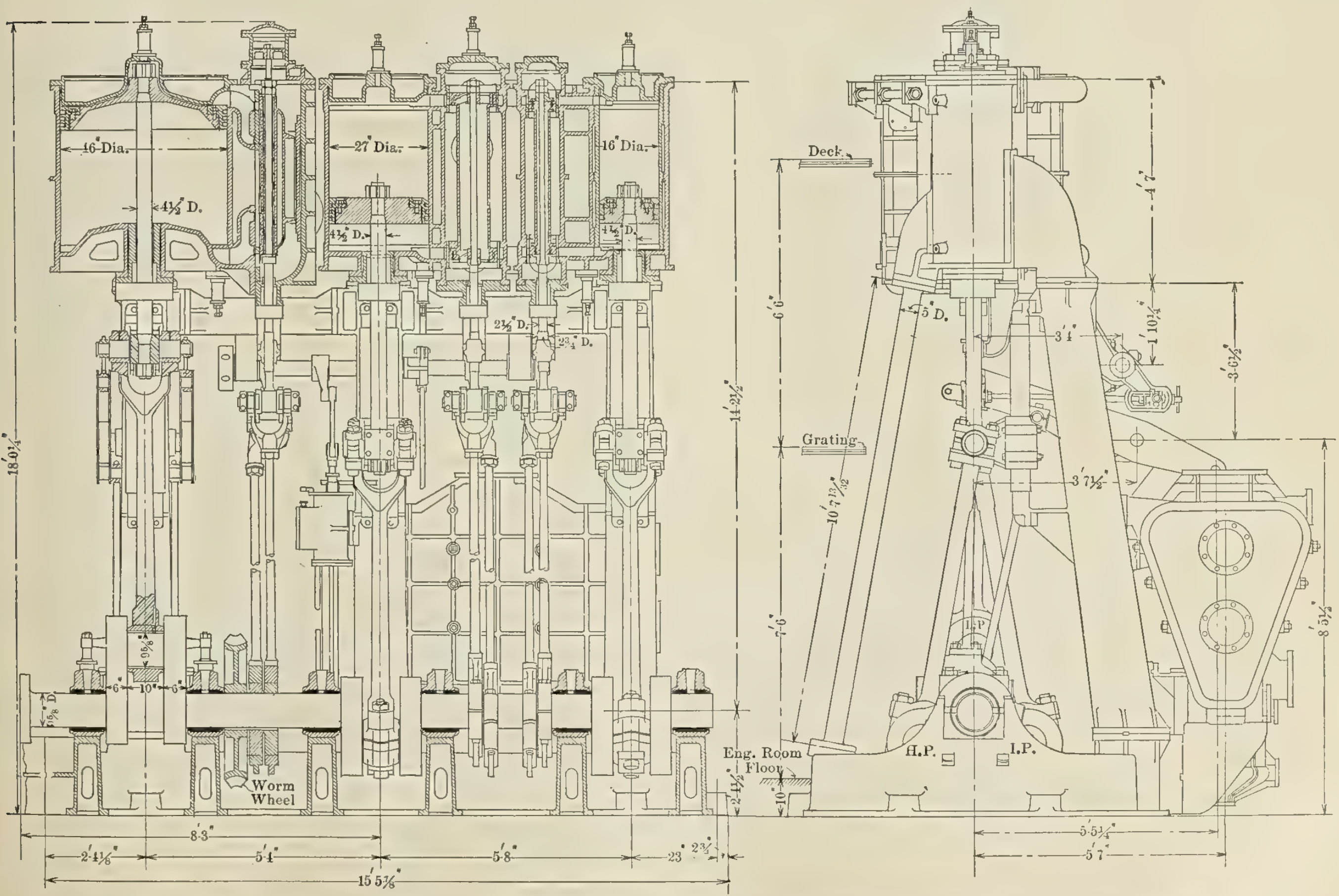

Fig. 4.—Main Engines—Cylinders, 16, 27 and 46 Inches Diameter; Stroke, 33 Inches; Revolutions per Minute, 110

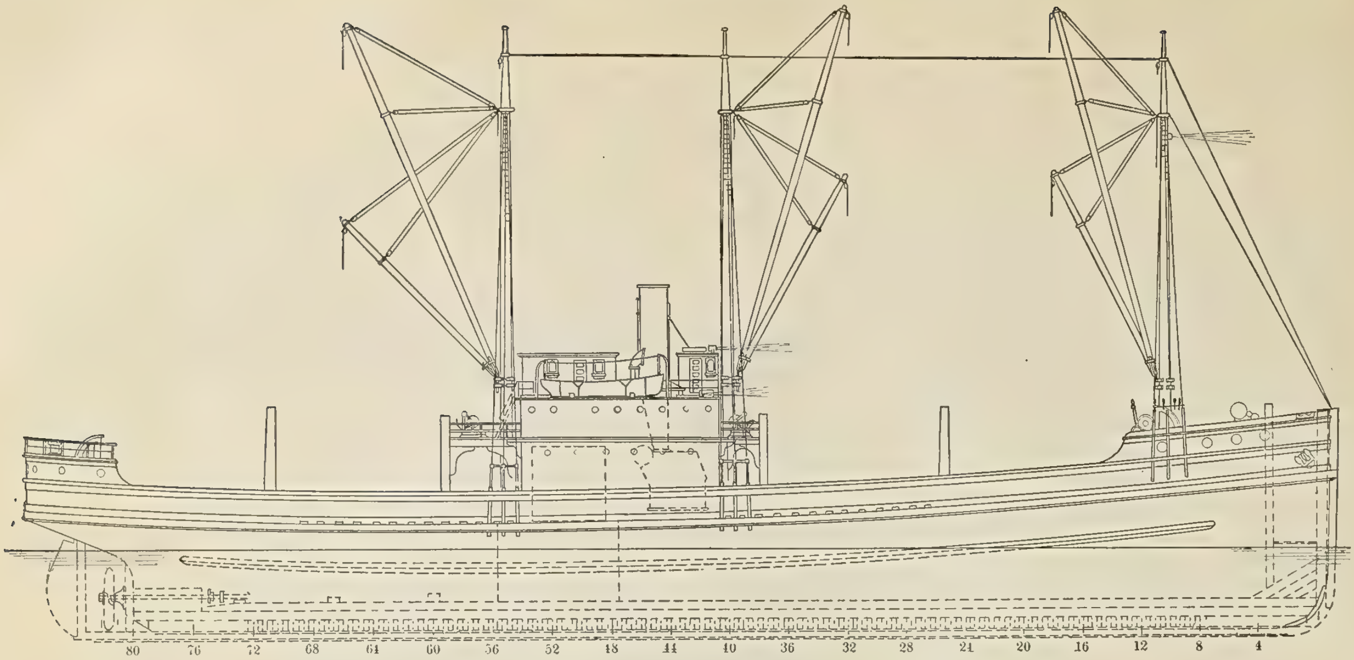

Fig. 5.—Outboard Profile

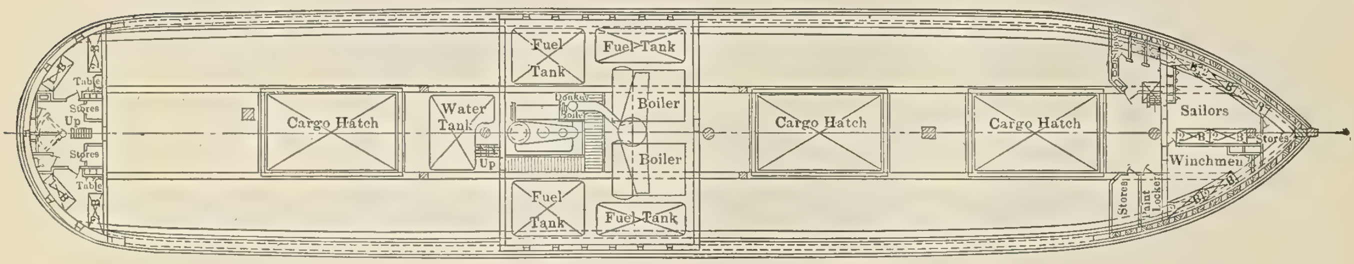

Fig. 6.—Plan of Main Deck

supervision of Captain Johnson and James Pendergast.

The principal dimensions of the two craft are: length over all, 235 feet; length from after side of rudder post to rabbet of stem at load waterline, 225 feet; extreme beam, 44 feet; depth of hold from top of 12-inch ceiling next to sister assistant keels onto the under side of deck planking, 17 feet; gross measurement, 1,497 tons; net register, 1,105 tons.

As shown by the general plans, Fig. 8, these vessels are single screw, with straight stem and elliptical stern and fitted with three masts, which handle the cargo gear. Double booms are fitted on each mast as shown, in order to facilitate the loading and discharging of lumber or other cargo.

The full width of the deck is carried as far fore and aft as possible to permit of the deck load being stowed in as long lengths as possible; and the after body lines will show that the buttocks are kept as straight as possible and the waterlines fairly full in order to give good lumber stowage in the after hold and at the same time keep the vessel rather fine aft in order that she might handle well.

The general arrangements of the vessel have practically been decided by the position of the cargo gear, which is so placed as to give an equal amount of lumber for each rig to handle.

The original owners found that it has always been more expensive to handle lumber which is stowed alongside of the machinery space, and for this reason shortened up the house as much as possible and built it to the full width of the ship.

Boilers Placed on the Main Deck

It will also be noted that the boilers have been placed on the main deck, instead of the hold, as is usual. This arrangement gives a little more cargo space and does away with the necessity of building a light and vent trunk.

This arrangement allows of inside doors for all rooms in the crew accommodations, a feature which will be appreciated on the Pacific Coast, where the strong summer winds make this arrangement advisable.

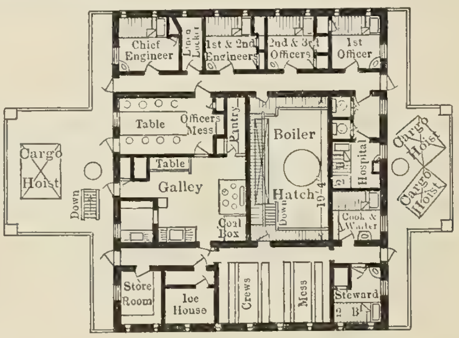

Fig. 7.—Accommodation Plan of Upper Deck

The fuel oil tanks are placed alongside of the engine, both in the hold and on deck, and it will be noticed that the arrangement is very compact.

The officers' accommodations are all in the midship house and very comfortably arranged. As many comforts have been provided here as possible, the vessels being

NEW PACIFIC COAST STEAM SCHOONERS

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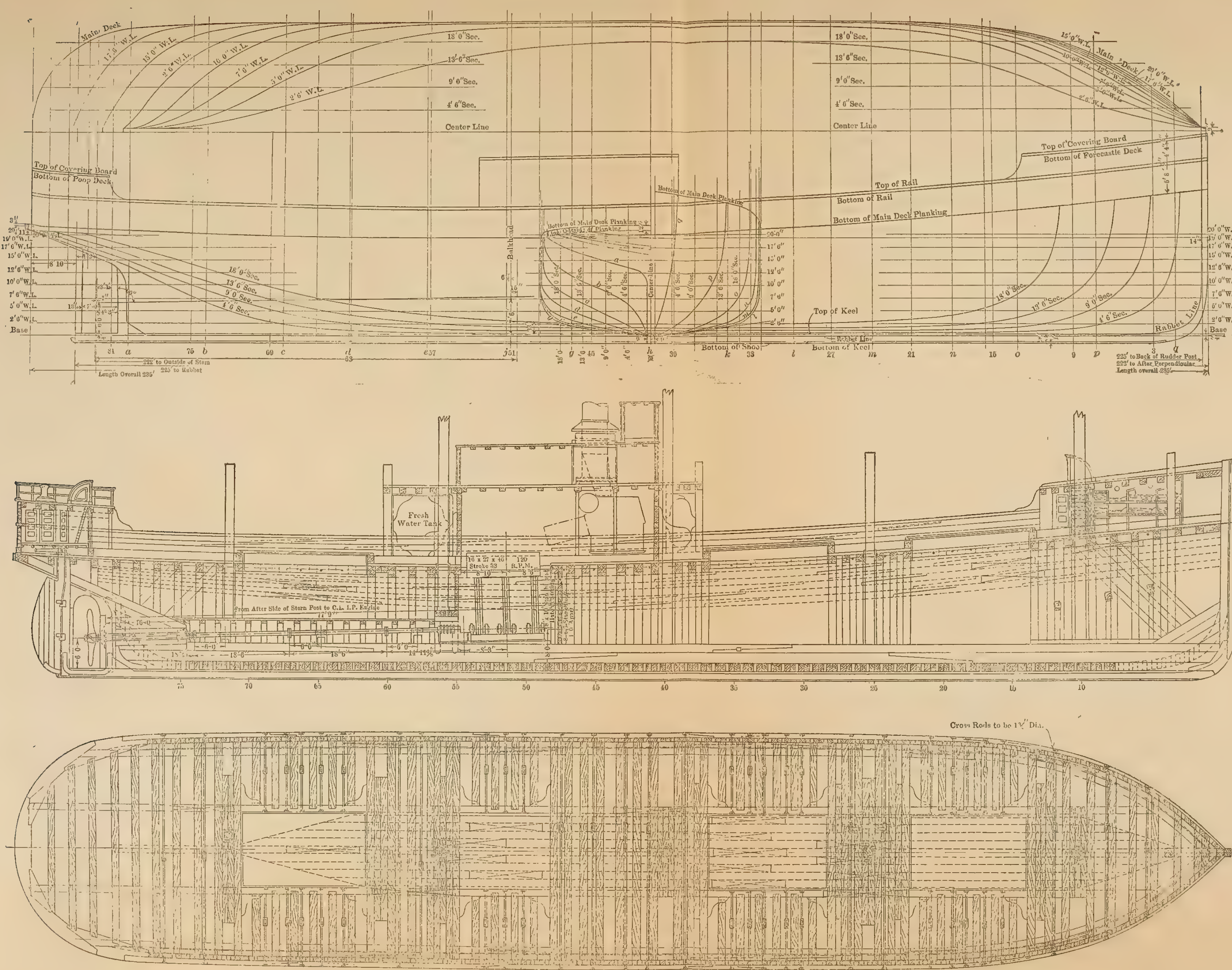


Fig. 8.—Displacement Lines to Outside of Planking and Construction Plans

intended for long, off-shore voyages whenever the occasion arises for their use in such trades.

On the hurricane deck there is a pilot house, which has been made 16 feet wide, in order to accommodate the officer on watch, as well as the man at the wheel; and the captain's stateroom, office and bath, which occupies a house 16 feet square. On the Pacific Coast in late years it has been the custom to build a shelter house on the bridge for the officers and watch, owing to the cold winds in the summer and the rains on the northern runs in the winter months. In these vessels the two have been combined, the pilot house being in reality a large shelter cabin similar to that which has been adopted on British steamers.

In the forecastle accommodations have been arranged for the crew, including showers, wash rooms and toilets, while the poop contains accommodations for the petty officers.

Hull Construction

Douglas fir was used almost entirely in the hull construction, with black iron fastenings in the hold and galvanized iron fastenings where exposed to the weather.

The keel is of Douglas fir in three lengths, sided and molded 18 inches and with 14-foot scarphs. The keel is fitted with a 3-inch pine shoe. The stem and stern posts are of oak, kneed as shown on the plans. The rudder post is of ironbark with an 18-inch rudderstock, also of ironbark, backed with pine and fitted with three sets of composition braces. The stuffing box is on deck. The deadwood is of pine, molded to take the heel of the cant frames.

The frames are of pine, sided 12 inches and spaced 32 inches centers, and in the wake of the house they are carried up to the upper deck. The ceiling is 12 inches thick and 16 inches wide on the back. The clamps are 14 inches by 16 inches; the deck beams are 16 inches by 16 inches, with a knee under every beam; the waterways are 16 by 16 inches and 14 by 14 inches; the deck is of 6-inch by 6-inch pine, and the planking 4 inches, with garboards 8 inches and 6 inches.

In the wake of the midship house one side of the frames is carried up to the floor of the upper deck.

The main keelson is of pine, sided 18 inches and molded 24 inches, in three lengths, with rider keelsons 18 by 18 and eight sister keelsons sided 18 and molded 24 inches. The main ceiling is worked out of 12 by 16-inch pine.

The clamps are 14 by 16 inches and average 60-foot lengths, keyed with 4-inch oak keys in the scarphs. The deck beams are of 16 by 16-inch pine spaced 2 feet 10 inches and crowned 7 inches, except in the wake of the hatches, where they are 24 inches apart, with a knee under each beam.

There are two hooks on deck forward and two sets aft, besides three pointers of 14 by 14-inch pine with 10 by 18-inch stanchions, with an iron bar cap on the top.

Between the pointers forward 16 by 16-inch panting beams are fitted. The hatch ledges are continuous from stem to stern, stopping at the intersection of the waterway. Alongside of the cargo hatches and engine hatches tie-rods are fitted, as shown on the plans, of 1¼-inch diameter and turnbuckles between. The deck is of 6 by 6-inch pine, long lengths as possible, and the bulwarks are 5 feet high and built as shown on amidship section.

The garboard strake is 8 by 16-inch, and the second garboard is 6 by 16 inches, while the remainder of the planking is 4 inches thick, except the wales, which are 6 by 8 inches, except one 10 by 12-inch strake to carry the lower fender. The shaft log is of pine, made in two pieces 18 by 36 inches, with white cedar stern timbers. The Sampson posts are 24 by 24 inches at the deck, tapered to 18 by 24 inches at the top. The fenders are 10 by 15-inch pine capped with 4 by 12-inch ironbark.

The arrangement of the forecastle deck house and poop

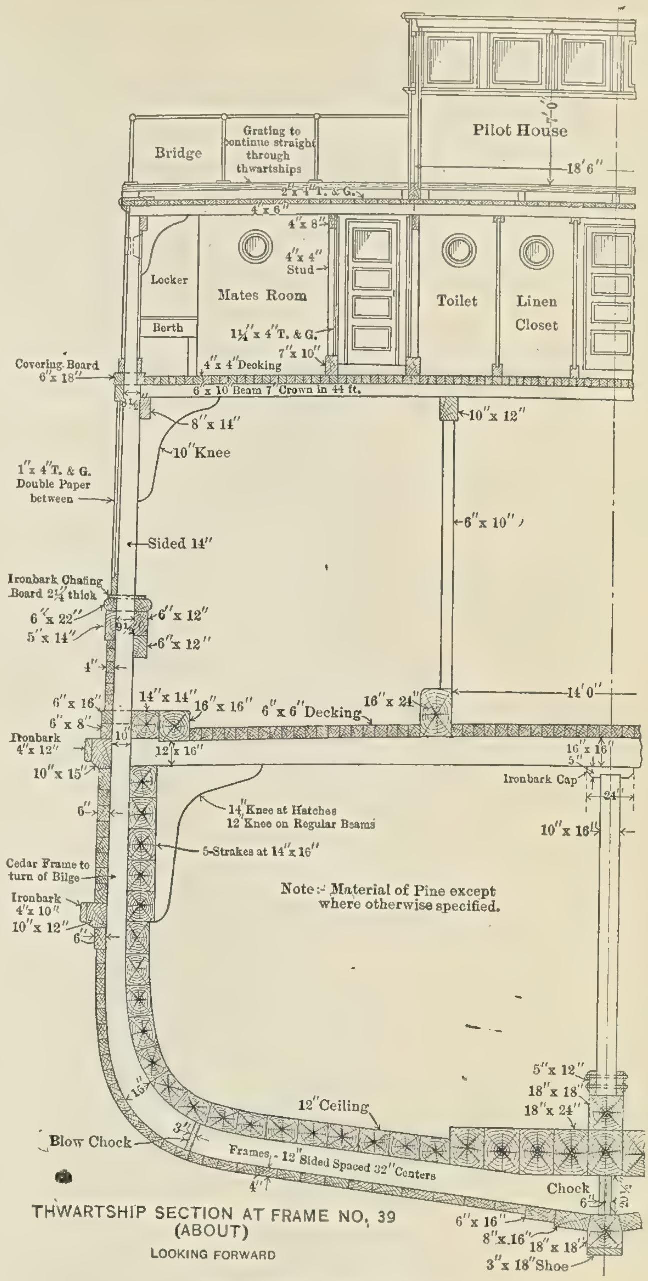


Fig. 9.—Midship Section

are shown on the plans, and it will be noticed that there is a winch deck just forward and aft of the midship house to keep the cargo winches clear of the deck load.

Propelling Machinery

The vessels are fitted with Ward watertube boilers having a combined heating surface of 4,000 square feet and 52 square feet of grate area, furnishing steam at 225 pounds pressure. The owners have the idea in mind that should the vessel be on a run where coal was cheaper than oil, to have sufficient heating surface to steam easily with coal. The engines are triple expansion, with cylinders 16, 27 and 46 inches in diameter with 33-inch stroke operating at 110 revolutions.

These engines were designed and built by the Main Street Iron Works, of San Francisco. The high and in-

termediate cylinders are fitted with piston valves; the low with a double-ported slide valve.

The principal aim in the design of these engines has been—

First—To economize on space, and therefore all valve gear has been placed on the inside.

Second—Economy in operation.

In this respect the clearances in each end of the cylinders have been reduced to a minimum by shortening up the length of the ports.

The engines are of the standard triple-expansion design, with this exception, that they are fitted with a cast iron box type of guide, which is a departure from the usual and accepted standard.

The surface condenser is of the Weir four-flow type, having a length of tube of 6 feet, with a surface of about 50 percent less than as usually designed. It is cast separate and is bolted to the high and intermediate columns. The air pump is of the Edwards type. The water enters at the bottom, with the outlet at the top.

The thrust bearing is of the horseshoe type, and is fitted with water circulation in the collars. There are two feed and two bilge pumps worked from the low pressure crosshead.

These engines have proved remarkably economical in fuel consumption, due to the cylinder ratio and number of expansions. They were built for a guaranteed output of 1,000 indicated horsepower, having in view, however, that this would be only at economical cruising speed, with the cut-off run in on the high and intermediate cylinders so as to get a high number of expansions. They will develop 1,250 indicated horsepower at an economical speed. On the trial trips the engines showed practically no vibration.

The low pressure piston is of cast steel, made as light as possible, and is counterbalanced by the weight of the air, feed and bilge pumps, while the intermediate pressure piston is cast solid, as well as the high. This was done to minimize as much as possible the unbalanced weights of the pistons, which set up vibration.

The electric light plant is a General Electric 10-kilowatt, direct connected set; the ice plant a one-half-ton Brunswick machine; the steam steering gear is of the standard Dake type. The cargo winches are of the 8-inch by 12-inch Filer & Stowell oscillating type, with a single drum, two to each mast. A new feature on these boats is a warping engine designed under the supervision of Mr. James Pendergast, the marine superintendent of the Sudden & Christenson Company. This warping engine has steam cylinders 7 inches by 10 inches double, geared 13 to 1 to the gypsies.

All the auxiliary machinery in the engine room is in separate units, the vessels having independent line, bilge and other pumps.

On a trial trip on San Francisco Bay, with a draft of 7 feet forward and 14 feet 6 inches aft, these vessels made a speed of 12.09 knots, the boiler pressure being 225 pounds, first receiver 85 pounds, second receiver 10 pounds, and a vacuum of 25½ inches, turning a propeller 11 feet 6 inches in diameter, 12 feet pitch and 40 percent surface at 115 revolutions per minute.

Loaded with 1,400,000 feet of spruce and with a draft forward of 18 feet and a draft aft of 20 feet 6 inches they showed a sustained speed at sea on a 72-hour voyage of 11.2 knots, on a fuel consumption of 82 barrels of fuel oil per day, the engines developing about 1,150 horsepower. On this trip the deck load was 18 feet high forward and 12 feet high aft, the condition of the bar where she was loaded preventing the vessel from being loaded to draw more than 20 feet 6 inches. On a draft of 21 feet 6 inches she will carry slightly over one million and a half feet of lumber.

Boats for the New York Barge Canal

THE annual report of the New York State Engineer and Surveyor has the following to say with reference to the lack of vessels for navigating the New York Barge Canal:

During the past year much has been said in the public press as to the lack of boats suitable for use on the new canal. It is true that such a condition exists. There are practically no boats of a type suited for efficient operation on the new system, and few, if any, are in course of construction. When the canal was planned it was assumed that the boats to operate in its channel would be provided by private capital, and such was the logical conclusion to draw. The war, however, has entirely changed this aspect of the situation, and without definite assurances from the Federal Government that it will co-operate, it seems very doubtful if capital can be attracted to this field until peace returns. This is not surprising, inasmuch as capital cannot now be induced to take up any new transportation scheme unless the Government renders assistance. The unfortunate condition exists, however, that if a decision to help is not speedily arrived at, this splendid canal will not be permitted to play its part as a war resource this coming navigation season, not because it will not be open for navigation, but because there will be practically no equipment to float upon it.

In assuming control of the railroads, the Government becomes supreme in matters of transportation. It can dictate the nature of shipments and the routes to be followed. The first assistance, then, on the part of the Government to be given private capital interested in the construction of canal barges should include assurance of freight to carry. In view of the railroad situation, this ought to be simple. Anyone who is at all conversant with the subject knows that the cost of shipping by water is less than by rail, and to those who have given the subject deeper study, the popular conception of the slow-moving barge as compared to the "fast freight" is known to be erroneous. Tonnage has for years slowly, but surely, been diverted from the canals of New York State to the railroads. It is not necessary to review the reasons for this, but the canal advocate believes such to be the case, and an examination of the records of the departments presided over by the officials charged with canal matters appears to verify the contention.

Reasonable time of delivery on materials entering into the construction of barges is for the greater part subject to priority orders. Assurances should be forthcoming from the Government as to the certainty of receiving promptly these materials, and once the barges are placed in commission the owners and operators should feel that they are not to be commandeered for use in other waters.

The boat situation as related to our canals is a serious one. The State, after constructing the canal which connects the Atlantic seaboard with the Great Lakes, should not be expected to build the barges. Millions of tons of freight pass through the State. The canal in 1918 can carry 10,000,000 tons between Lakes and tidewater and thus release thousands of freight cars for use in sections of the country where inland water transportation has not been developed to the extent it has in New York State. To win the war it has been stated that the United States must build boats, boats and more boats. The result which could be accomplished by placing a limited number in commission on the Barge Canal is self-evident.

Concrete Barges and Ships*

Comparison with Steel and Wooden Vessels—Strength, Elasticity and Cost—Tentative Designs

THE idea of building ships or other floating vessels of reinforced concrete is not new. For many years and in several different countries attempts have been made from time to time to build small boats and barges of reinforced concrete. From the information at hand, apparently some of these attempts have been successful and the vessels thus built have been in use for considerable periods. However, no definite information regarding boats built prior to the war is at hand which would assist in solving the general problem of the concrete ship.

Since the beginning of the war, however, owing to the loss of the world's tonnage due to submarine sinkings, the attention of many naval architects, concrete engineers and others has been drawn to the question of concrete ships to replace those sunk. The scarcity of steel, wood and labor, and the length of time necessary to construct ships of steel or wood direct attention generally to the substitution of reinforced concrete. Norway appears to have taken the lead in this work, and two different companies are already building ships of concrete. The Porsgrund Cement Works, whose vice-president and general manager, Mr. Jens Hauland, has recently been in this country, has already launched one or more ships of 100 tons cargo capacity and is reported to have under construction a ship of 1,000 tons cargo capacity. The general design of these ships follows generally that of a framed steel ship. According to Mr. Hauland, the weight compares very favorably with that of a steel ship. No definite information is available, however, by which this statement can be verified.

The Fougner Steel Concrete Shipbuilding Company, of Christiania, Norway, has been building vessels since June, 1916. About eighteen in all have been launched up to the present time. Several others are under construction. The *Namsenfjord,* about 400 tons displacement, launched some time ago, has made a round trip between Norway and England. No detailed information is available at the present time regarding these vessels that would throw light on the general problem.

On this side of the Atlantic, at least two ships are under construction. At San Francisco a large ship about 5,000 tons capacity is being built. This ship is 320 feet long, 44 feet 6 inches beam and 30 feet deep. At 24 feet draft the displacement is said to be 8,000 tons. The weight of the hull is said to be 2,200 tons. At Montreal, Canada, a small concrete ship which will have about 300 tons carrying capacity has already been launched and is now being equipped. This vessel is being constructed by the Atlas Construction Company, Limited, of which Mr. Chas. M. Morssen is president. This ship is 126 feet long between perpendiculars, 22 feet 6 inches beam, with a depth of 12 feet 6 inches. The displacement is about 650 tons. The ship will be self-propelled, and is now being equipped with boilers and engines. She will shortly make her first trip. No estimate of cost is at present available.

With the exception of the two ships noted above, little information has been gained from the ships now under construction which will assist in the solution of the concrete ship problem.

The present report will confine itself to a general statement of the several elements which make up the concrete ship problem and a discussion of the information obtained from the tentative design of a concrete ship.

In order to make any advance toward the solution of the concrete ship problem, information must be obtained concerning several points regarding which only meager information is now available. These points taken together constitute the concrete ship problem.

Relation Between Carrying Capacity and Displacement

It is apparent that the efficiency of a ship as a cargo carrier depends upon the relationship between deadweight and displacement. Expressed in terms of percent, in the average cargo ship built of steel, the deadweight is from 70 to 75 percent of the displacement—taking into account as weight of ship all spars, fittings, deck houses, anchors and chains, auxiliary engines and tanks, but not boilers, engines or coal. In a wooden ship, the deadweight is from 60 to 65 percent of the displacement. It is quite evident that from the difference in weight of materials it will be difficult to design a ship of concrete that will give a relationship between deadweight and displacement approaching that of steel. However, if ships are to be built of concrete for commercial use, the weight of the ship must be such as to provide a reasonable deadweight or cargo capacity for the displacement.

Transverse Strength

The stresses in the transverse members of a ship are in still water functions of the draft and the stiffness, and may be computed by mathematical processes, although the computations are long and laborious. When the material is reinforced concrete the problem becomes much more complicated. Experience has shown, however, that numerous elements other than draft affect the transverse strength of a ship, such as the effect of rolling in a seaway, impact with docks or other ships, and stresses incident to going into dry-dock. The transverse members of cargo ships of to-day are, therefore, not designed to withstand computed stresses, but are designed in accordance with various rules which embody the result of long experience in the construction and use of ships. It should be noted in this connection that granting of insurance depends on compliance with these rules.

Steel ships are of two different types—(a) framed ships, in which transverse frames are spaced from 18 to 24 inches on centers, the plating being riveted to these frames without intermediate longitudinal members, excepting in the bottom; and (b) longitudinally framed ships (Isherwood), in which heavy frames are spaced from 10 to 15 feet on centers, with intermediate longitudinals to which the plating is riveted.

From a comparison with the ordinary steel ship design it would not appear to be difficult to design transverse members of reinforced concrete of equivalent strength to steel members—the question of strength only being considered.

Longitudinal Strength

In a steel ship the entire cross-sectional area of the midship section acts to resist the alternate tensile and compressive stresses, taking into account, in determining

*Report of the joint committee of the American Concrete Institute and Portland Cement Association on concrete barges and ships, November 27, 1917.

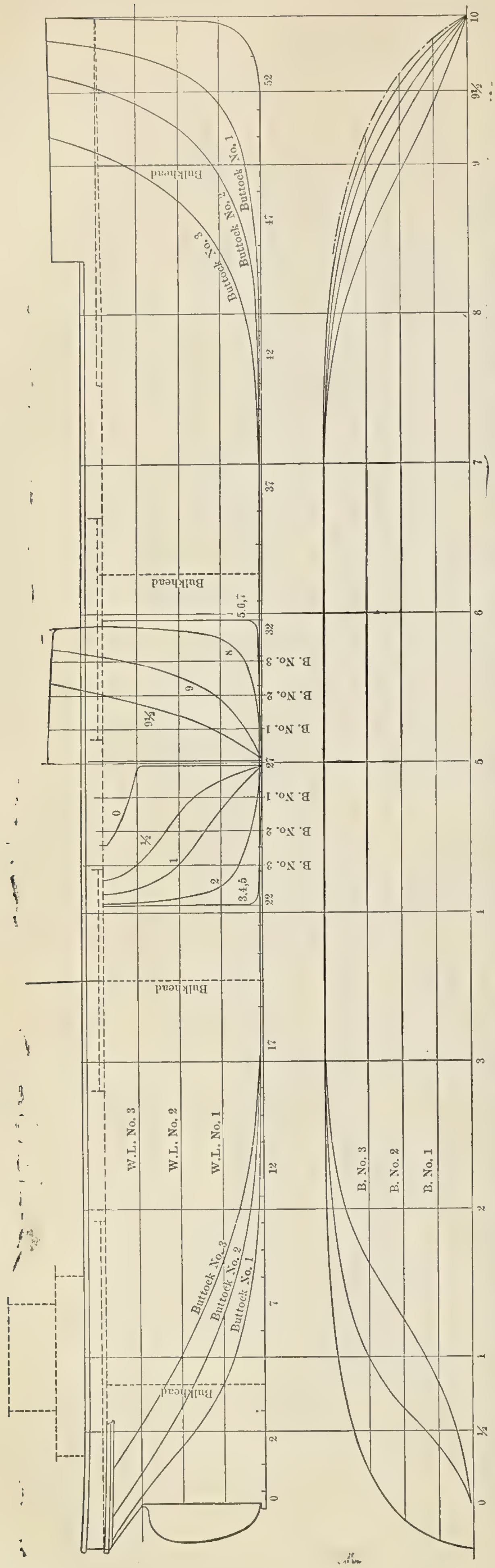


Fig. 1.—Lines of Reinforced Concrete Barge, 227 Feet 6 Inches Long Overall; 42 Feet Beam and 23 Feet Depth; Displacement at 18-Foot Draft, 3,650 Tons; Block Coefficient, 0.77

the moment of inertia, all of the continuous members, such as continuous scantlings and deck, side and bottom plates. In the concrete ship, equivalent strength must be provided. In the case of the concrete ship, however, only the steel reinforcement can be relied upon to take tensile stresses. The concrete, assisted by the steel, will take the compressive stresses.

The effect of the rapid change of the character of the stress in either the deck or the bottom is much more serious in the case of concrete ship than in the steel ship, for the reason that, owing to the low tensile stress of concrete, cracks will occur at the extreme fiber under relatively low tensile stresses in the steel. These cracks, if any, alternately opening and closing, may tend to cause disintegration, with resulting leaks or impairment of the reinforcement.

At the present time little information is available as to the effect of such reversal of stress, and but little can be hoped for until an actual trial has been made of a concrete ship in a sea.

Elasticity

There is an almost unanimous opinion among naval architects and seafaring men generally that a concrete ship will be so inelastic that she will tear herself to pieces in a sea. While it is doubtless true that in a concrete ship there will not be the same readjustment of stresses as in a steel ship when subject to the action of a heavy sea, experience with reinforced concrete structures generally has shown that such structures have considerable elasticity, and there is ample reason for the hope that reinforced concrete will prove a suitable material for shipbuilding purposes.

Effects of Sea Water on Concrete and Reinforced Steel

Until very recently, little information has been available as to the effect of sea water on concrete. The recent work of the Bureau of Standards, acting in co-operation with the Portland Cement Association, has thrown considerable light on what may be expected from the action of sea water. The result of their investigation tends to show that inferior concrete or concrete of which the surface skin has been impaired suffers serious disintegration when in contact with sea water. Inasmuch as in most instances the structures examined which form the basis of the report of the Bureau of Standards, were built without thought as to the action of sea water (it being assumed that there would be no deleterious action), there is every reason to hope that where the effect of sea water is appreciated, and where steps are taken in the way of selected materials and adequate workmanship, assuring a good mix and a satisfactory surface skin, the concrete will not so deteriorate.

With regard to the effect of sea water on the reinforcing steel, there is some question as to whether a thin layer of concrete can be relied upon to protect the steel from corrosion. To provide a thick protective layer of concrete outside of the reinforcing steel is practically out of the question, owing to the large increase in weight. If the reinforcement, therefore, is to be maintained in perfect condition, the steel must be protected by galvanization and by increasing the efficiency of the protective concrete by means of additional care in materials and workmanship and by a surface coating of a waterproofing character.

Relative Cost

Just at the present time the demand for tonnage is so great that any ship of reasonable capacity that can be used for carrying cargo will prove financially successful.

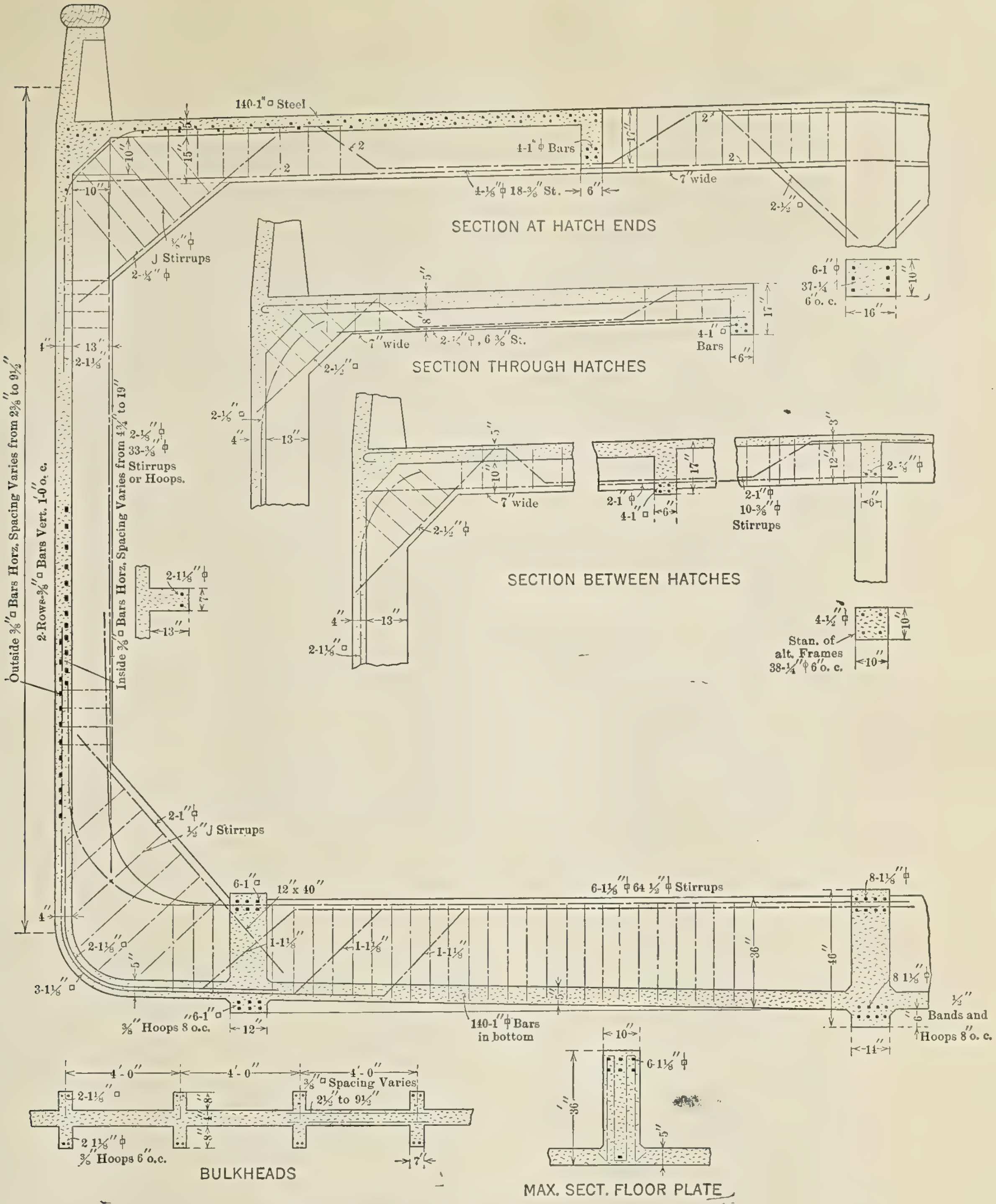


Fig. 2.—Midship Section of Reinforced Concrete Barge

The relative costs of ships of concrete and steel or concrete and wood is not, therefore, as important a consideration as it will be after the war when conditions again approach the normal. However, it is necessary to have an adequate idea of the probable cost of a concrete ship, as well as comparison with the cost of steel and wooden ships.

Speed of Construction

Speed of construction is of vital importance in the shipbuilding programme to-day, owing to the immediate requirements for tonnage. If it shall be found that the concrete ship can be constructed in much less time than a steel or wood ship, this fact will contribute largely to the success of the concrete ship.

Ships devoted to carrying of cargo may be divided for the purpose of this report into two general classes: those adapted to use in still waters, such as harbors, rivers and canals, and those adapted for use at sea, in which provision must be made for wave action.

Tentative Design for a Concrete Barge

Ships for use in still water do not present the same problems of construction as do ships for ocean service. Owing to the need of barges of from 100 to 150 feet in length for use on the canals of New York State, it was the committtee's first thought to devote study at this time to the design of a barge which would be suitable for this service. After considerable study and discussion with various naval architects, including the firm of Cox & Stevens, of New York, who were retained by the committee in an advisory capacity, it was deemed advisable to abandon the study of a small still-water barge, for the

reason that while such a study might result in considerable information as to the cost, method of construction and deadweight, compared to displacement, the problem which is of vital importance to solve at this time, namely, whether or not concrete can be adapted for ships necessary for transatlantic and coastwise service, as well as possible service on the Lakes, would remain unsolved, and little or no information would be obtained bearing on this phase of the question. It was, therefore, decided to devote the study to a ship of the seagoing type. In order to simplify the problem as far as possible without omitting any essential elements it was decided to select a barge to be towed rather than a self-propelled ship. This would eliminate all consideration of weight of all boilers and engines, excepting such as would be required for auxiliary hoisting machinery. Because of the fact that so little is known regarding the concrete ship, it was deemed advisable to keep the ship as small as possible. It was thought at first to limit the size to an assumed carrying capacity of 1,000 tons or less.

After many conferences by the committee with its consulting naval architect, it was decided to increase the capacity to about 2,000 tons, it being the decided opinion of the naval architects that a ship smaller than 2,000 tons would have little commercial value after the war, although during the war it would probably prove successful.

In the absence of any reliable data as to the relation between deadweight and displacement for concrete ships, an assumption was made that the deadweight would be approximately 55 percent of the displacement for the proposed tentative barge. Upon this supposition the consulting naval architects laid out the lines for the proposed ship. The dimensions are as follows:

Length (over all)	227 feet 6 inches
Length between perpendiculars.......	220 feet 0 inches
Beam	42 feet 0 inches
Depth	23 feet 0 inches
Loaded draft	18 feet 0 inches

The hull was given lines such as would provide maximum carrying capacity and still permit reasonable towing and adequate control. At an 18-foot draft the displacement will be about 3,675 tons; at 19-foot draft the displacement will be about 3,860 tons.

The general dimensions of the barge and the lines are indicated in Fig. 1. It should be noted that the midship section of the hull is rectangular, with the exception of a slight crowning of the deck and a slight inclination of the bottom upward toward the bilges (dead rise). The deck is straight throughout and continuous from stem to stern. The ship is divided into five compartments by four transverse bulkheads; the foremost and aftermost compartments are to be used for tanks and ballast, while the three center compartments are for cargo. The cargo compartments are served by three hatches—each about 14 feet by 19 feet.

As has already been noted, the actual stresses in the structural members of a cargo ship are not usually computed, but sections are adopted which long experience has shown to be safe.

After consultation with the naval architects, it was thought desirable to take as a criterion a steel ship designed in accordance with the rules as laid down by Lloyd's and provide equivalent strength in reinforced concrete, with such modifications as the difference in material would make necessary. It was assumed that the concrete for the ship would be poured, as in a concrete building. A limit of 3 inches was placed upon the thickness of the concrete, as that was considered the minimum thickness that can be poured satisfactorily.

The question of weight being vital in the design of a concrete ship, it was deemed desirable to assume a concrete of high crushing and shearing strength. A concrete of one part Portland cement and one part carefully selected sand and two parts selected gravel (about ½ inch) was decided upon, which if properly mixed should give an ultimate crushing strength in excess of 3,000 pounds per square inch. The stress in the concrete in extreme fiber was limited to 1,000 pounds per square inch. In order to reduce the danger of cracking the concrete in extreme fiber, a large percentage of steel was assumed with a resulting low-tensile stress.

For a ship of the same size, Lloyd's rules require that the frames be placed 24 inches on centers. This was deemed too close for economical use of concrete and a spacing of 4 feet was adopted, making the resisting moment of each frame at all points equivalent to twice the resisting moment of one frame in the steel ship. In determining the strength of the frames of the steel ship as fixed by Lloyd's rules, no allowance was made for the effect of the tank top (floor of the hold) or of the bottom plating. Assuming a spacing of frames of 4 feet and a resisting moment equivalent to two frames, under Lloyd's rules, the floor plate or transverse girder supporting the ship's bottom was found to require a concrete girder 36 inches deep and 10 inches wide, including the bottom slab.

To provide for the negative and positive bending moment in the shell, two lines of reinforcement were assumed—one near the outer surface and one near the inner surface. The load being uniform, the positive bending moment at the center between frames will be approximately one-half of the negative bending moment at the frames. Two-thirds of the total amount of steel was therefore provided near the outer surface and one-third near the inner surface. All the bars are straight, it being considered impracticable to bend the bars. From the lower turn of the bilge up to the deck, one size of bar was assumed with variable spacing to meet the required strength at different depths. The thickness of the shell from the upper turn of the bilge to the rail was fixed at 4 inches. To provide adequate strength against "hogging" or "sagging," tension steel to the extent of 140 square inches was provided in both deck and bottom. This steel was considered also as providing reinforcement for local stresses in the bottom, due to hydrostatic pressure, and in the deck, due to load. It was placed in two layers to take up both negative and positive moments, two-thirds being near the outside surface and one-third near the inner surface. Since this steel will be subject to compression as well as tension, the two layers were securely tied together to prevent buckling. To provide adequate protection to the steel and also to provide sufficient area in concrete to take up the compression stresses, the thickness of the bottom up to the upper turn of the bilge was made 5 inches. The deck between the bulwark and the line of the hatch coamings was made 5 inches also. The deck between hatches and within the lines of the hatch coamings was made 3 inches thick. The deck itself not being sufficient to provide sufficient area in concrete, additional area was added at the junction of the deck and the sides, where it would also tend to increase the resistance to horizontal shear, which would be high at that point.

In the bottom three longitudinal members running from bow to stern were provided, one on the centerline and one at each lower turn of the bilge. These longitudinals or "keelsons" give longitudinal stiffness, assist in distributing the load due to dry-docking and provide additional area for hogging and sagging stresses.

The vertical frames in the sides were made 7 inches wide and 17 inches deep, including the shell, and an

equivalent in strength to steel frames, under Lloyd's rules. At the junction between the floor plate and the side frames a heavy gusset is provided to give additional strength at that point. A similar gusset is provided between the frames and the deck beam. This gusset is increased in size at the beams at hatch ends. The deck along the centerline is supported by means of posts at the ends of each hatch and at alternate deck beams between hatches.

The bulkheads consist of 4-inch slab reinforced near both surfaces and stiffened by reinforced ribs 20 inches in depth over all and 7 inches wide, spaced 4 feet on centers.

Estimate of Quantities and Weights

A conservative estimate of quantities required for the proposed barge gives the following:

Concrete..............................	731 cubic yards
Steel..................................	482,000 pounds
Yellow pine timber for floor of hold..	30 M feet b. m.
Oak timber for fender and rail......	15 M feet b. m.

Taking the weight of concrete at 144 pounds per cubic foot, weight of steel 490 pounds per cubic foot, and weight of wood 48 pounds per cubic foot, and making an allowance of 77 tons for deck machinery, anchors and chains, spars, water tanks and deck houses, the total weight of ship would be 1,647 tons. Taking the displacement of 18 feet draft at 3,675 tons, the carrying capacity or deadweight could be 2,028 tons. Assuming 19 feet draft, the displacement would be 3,860 tons and the deadweight capacity 2,213 tons.

Cost

Assuming sand, stone, cement and reinforcing steel at current prices, the cost of the hull (exclusive of any equipment, such as deck houses, spars, anchors and chains, engines, boilers and tanks) would approximate $118,000 (£24,200). Assuming the construction of ways, which could be used for the construction of five or more ships, the cost of ways per ship would approximate $8,000 (£1,640), making a total cost of the hull (exclusive of equipment), $126,000 (£25,800).

Based on the figures noted above, the cost of the hull per ton of deadweight would approximate $63.00 (13/2/6). Owing to a wide range in costs of steel and wooden ships of the same character, it is somewhat difficult to arrive at anything approaching a definite estimate for steel or wood ships. The best figures available seem to indicate that the cost of steel hull per deadweight ton ranges from $90 (18/15/0) to $120 (25/0/0), while the cost of a wooden hull ranges from $70 (14/11/8) to $100 (20/16/8).

Other Types of Concrete Ships

The designs of various other types of ship in which reinforced concrete has been proposed, either alone or in combination with structural steel, were examined.

In some of these designs cellular sides and bottoms are proposed. Although double sides and bottoms in ships have distinct advantages when the material is concrete, such a design appears out of the question, not only because of the considerable increase in weight, but also because of the added complication to the form work—already a large item in the cost of a concrete ship.

Designs have been proposed in which structural steel members are used as reinforcement. While such members assist somewhat in maintaining the lines of the ship during the construction of the form work, the added advantages can hardly offset the increased cost due to the fabricated steel work, and the inefficient use of the reinforcement.

One design has been proposed in which structural steel members are used to support a shell of reinforced concrete. While the claim is made that a ship can be built of the proposed design with only about one-half the steel used in a steel ship of the same capacity and at much greater speed of construction, the difficulty of making the two materials act together, thus avoiding cracks, makes the design as proposed of doubtful value.

The committee feels that it is not its function at this time to prepare any detailed plans for a concrete vessel. It is manifestly impossible to design a type of vessel that will be applicable to all classes of service. A barge for use on the canals of New York would not be an efficient type for use in harbors or on the Ohio or on the Mississippi.

Vessels heretofore built have demonstrated that the small barge for still-water service can be built and successfully operated. The solution of the larger problem of a concrete ship will include the solution of smaller vessel problem, in which questions of strength are not of the same prominence.

Although there are some questions regarding the concrete ship which can only be answered by actual experiment, the studies which the committee has made point to the commercial success of the concrete ship.

It is suggested that specifications for a concrete vessel should embody the following principles:

1. Both cement and aggregates should be selected with great care to insure a concrete of maximum efficiency.
2. The concrete should be placed in one continuous operation to insure monolithic construction. The concrete mixture should be such as will develop a crushing strength in excess of 3,000 pounds per square inch when tested in standard cylinders at 28 days. A concrete consisting of one part Portland cement, one part sand and two parts ½-inch aggregate may be expected to give such a concrete. The mixture and workmanship in placing must be such as will assure impermeability.
3. The reinforcing steel should be in the form of deformed bars and should be galvanized.
4. In parts of the vessel where cracks in the concrete would tend to cause leaks, the stress in the steel should be kept low (preferably less than 12,000 pounds).
5. Some form of elastic waterproofing coating should be applied to the hull below the deck.

The "Trackless Train" on New York Piers

THE great industries of the country are very much alive to the fact that labor is scarce. They realize that labor will probably be more scarce a few months hence, and many of these industries are fortifying themselves against such shortage by utilizing labor-saving devices (many of which are entirely practical and a means of effecting increases in capacity), relieving congestion and reducing the cost of operation, beside taking the place of men who can then be transferred to other and more urgent tasks.

Among these labor-saving devices, one that stands out prominently is the electric industrial tractor, better known, probably, as the "trackless train." This is simply a self-contained power unit which is used to pull trailer trucks loaded with material of various kinds in manufacturing plants, shipyards, lumber yards, freight stations and on piers and docks.

An interesting example of the unusual practicability of these machines is at Piers 4 and 5, the Pennsylvania freight terminal, in New York, which was one of the

Fig. 1.—Industrial Tractor with Loaded Trailer

Fig. 2.—Tractor Hauling Train of Empty Trucks

most congested railroad freight terminals in the country. Here the installation of the tractors and the "trackless train" method of industrial haulage has almost doubled the capacity of this terminal, and the increased tonnage is now handled with about half as many men as were formerly required.

This remarkable change was brought about by the employment of four small electric industrial tractors and 225 trailer trucks, *rebuilt from the old four-wheeled hand trucks formerly used,* and the utilization of the "trackless train" method of haulage, which is in its essentials the same as that of a railroad, the difference being that this system is not—as is the railroad—restricted to rails, and as a consequence is more flexible, and so more efficient.

Under the old system of hand trucking, 165 men were required to move about 25 carloads of freight across the platforms and into the cars themselves. Now, with the new system in operation, only 100 men are needed to load 40 cars with 440 tons of freight in the same time.

Being convinced of the soundness of the "trackless-

Fig. 3.—Interior of Pier Shed, Showing Nature of Package Freight to Be Handled

train" method, the officials in charge of these piers laid out the work in conformity with the method, and again the railroad system, in a general way, was used. They realized that to make the tractors most efficient they must be kept busy, so regular schedules were established and retained. Trailers were loaded at the point of origin and prepared for the tractor, which picked them up and deposited them at the destination, returning to the point of origin with empties, which were dropped and a new and loaded train pulled away to its destination, and so on interminably. The tractor was always busy, and because of this fact reached and retained a point of high efficiency.

The tractors in this instance not only reduced the number of men required for the work, but cut operating costs in increasing capacity, relieved congestion, which had, prior to this time, greatly handicapped the work.

Examples of "trackless-train" efficiency such as this are numerous and are not confined to any one industry, for the system and equipment are practical for almost any case where haulage is to be done either in shipyards or at terminals.

The cost of operating the tractors themselves is about equal to one man's wages, \$3.00 to \$3.50 (12/6 to 14/7) per day, and such trifling expense is inconsiderable when compared to the savings possible.

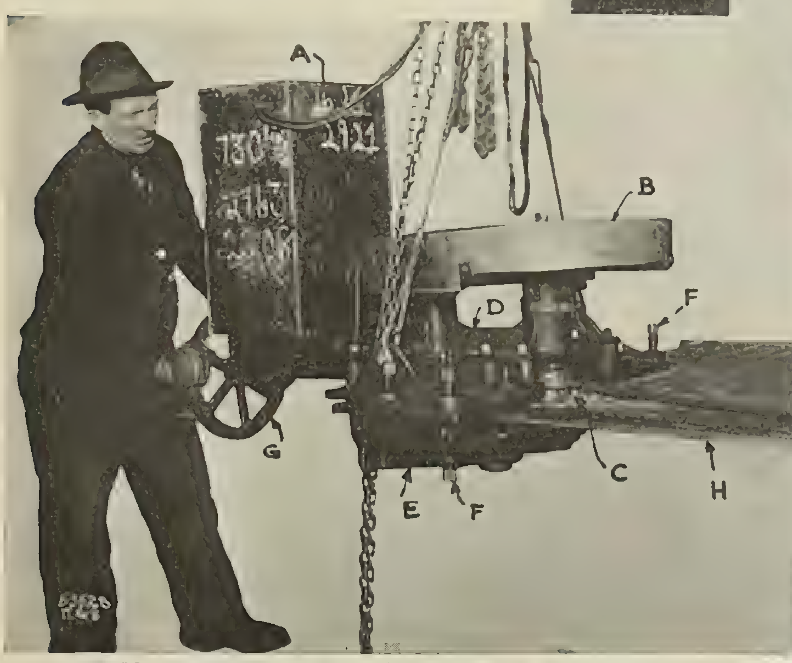
The tractors used on Piers 4 and 5 are the three-wheel Type Z machines made by the Mercury Manufacturing Company, of Chicago, and are equipped with 30 A 6 Edison cells.

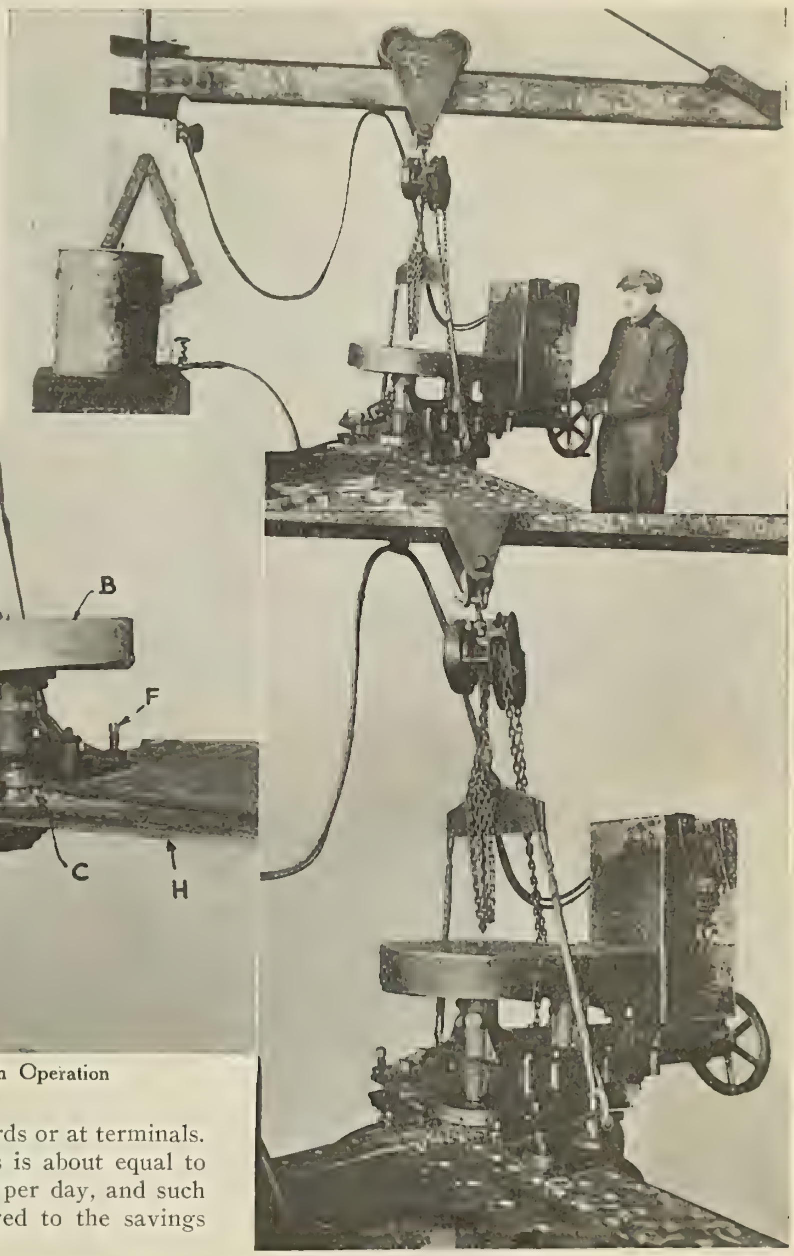
Skinner and Eddy Scarphing Machine

Heretofore the usual method of scarphing ship plates has been by means of air-driven chipping tools, with which the desired recesses are cut in the plate, a tedious and expensive procedure, resulting in work which is far from being accurate.

The time required for a skilled workman to chip an average scarph in the plating for a ship by this method is about one hour and fifteen minutes. With the scarphing machine illustrated, which has been developed and is manufactured by the Skinner and Eddy Corporation, Seattle, Wash., it is possible to cut a similar scarph in ten to fifteen minutes, or, allowing ten minutes additional for changing and resetting the machine, a complete, clean, accurately machined scarph may be completed every twenty or twenty-five minutes.

Referring to the illustrations, the box *A* contains an electric motor, which, driving through pinions and gears enclosed in the casing *B*, rotates a vertical shaft which carries at its lower end a milling cutter *C*. All the above mechanism is mounted upon a sliding carriage *D*, which is guided in the main frame *E*. This frame is clamped to the work by means of the set screws *F*. These screws permit a considerable range of adjustment, allowing scarphs of varying angles and lengths to be cut in the plate.





Views of New Plate Scarphing Machine in Operation

In actual practice, the machine is carried by a sling from a small jib crane, the plate being supported on trestles at a convenient height. After securely clamping the jaws of the frame *E* to the work, the cutter is fed into the plate by means

of handwheel *G* mounted on a feed screw working in a nut fixed in the frame *E*. On the completion of the scarph, the carriage is returned to the original position by reversing the direction of the handwheel *G*. The set screws may then be loosened and the machine readjusted in a different position for cutting a new scarph.

The design of the frame is such that a scarph may be cut at any point on the edge of the plate, or at the extreme corner, as shown in the picture, in which case the set screws on one side of the cutter only are used to clamp the frame to the work. The machine is also arranged with a swiveling head which allows scarphs to be cut at an angle with the side of the plate, as is sometimes necessary on shell plating at the ends of a vessel.

New Types of Wooden Ships Building in Texas

TWO new types of wooden ships are being built at Orange, Texas, known as the Daugherty and Piaggio types. An example of the Daugherty type, the *War Mystery*, a wooden steamship of 4,700 tons deadweight carrying capacity, was illustrated and described on page 216 of our April issue. Views of a Piaggio type ship, the *City of Gulfport*, are shown on this and the opposite pages.

The *City of Gulfport*, launched at Orange, Texas, recently took on a cargo at New Orleans for an Italian port. The gross tonnage of the *City of Gulfport* is 1,844 and the net tonnage 1,670. She has a spread of 4,760 square yards of canvas and is equipped with two 100 horsepower Fairbanks-Morse engines. There are electric lights and running water aboard, with bath rooms for the officers and crew.

The commander of the *City of Gulfport* is Captain Norman S. Winskill, twenty-seven years old, said to be the youngest captain on the Atlantic coast. Captain Winskill was formerly first mate on one of the United Fruit steamers.

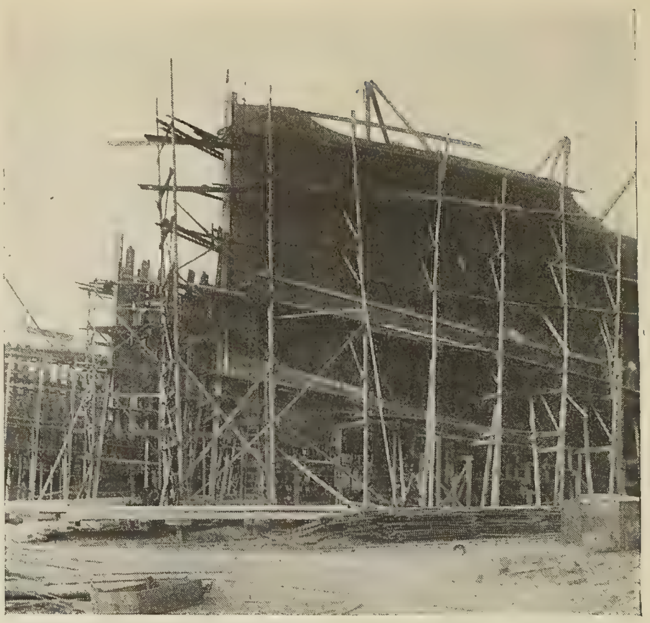


Fig. 2.—Daugherty Type Wooden Steamer Under Construction at Orange, Texas, Showing Diagonal Planking

In design and construction the *Daugherty* type ships differ radically from the Ferris type of wooden ship adopted by the Emergency Fleet Corporation. One of the principal differences is that the *Daugherty* type has a deadweight carrying capacity of 4,700 tons, as compared to 3,500 tons of the Ferris model, yet the larger vessel requires less than 1,500,000 feet of material to construct, as compared to approximately 1,750,000 feet required for the Ferris ship.

Fig. 1.—The *City of Gulfport*, Fourth Piaggio Ship Recently Launched at Orange, Texas

Fig. 3.—The *City of Gulfport* Ready for Her Maiden Voyage

Fig. 4.—View on Deck of *City of Gulfport*

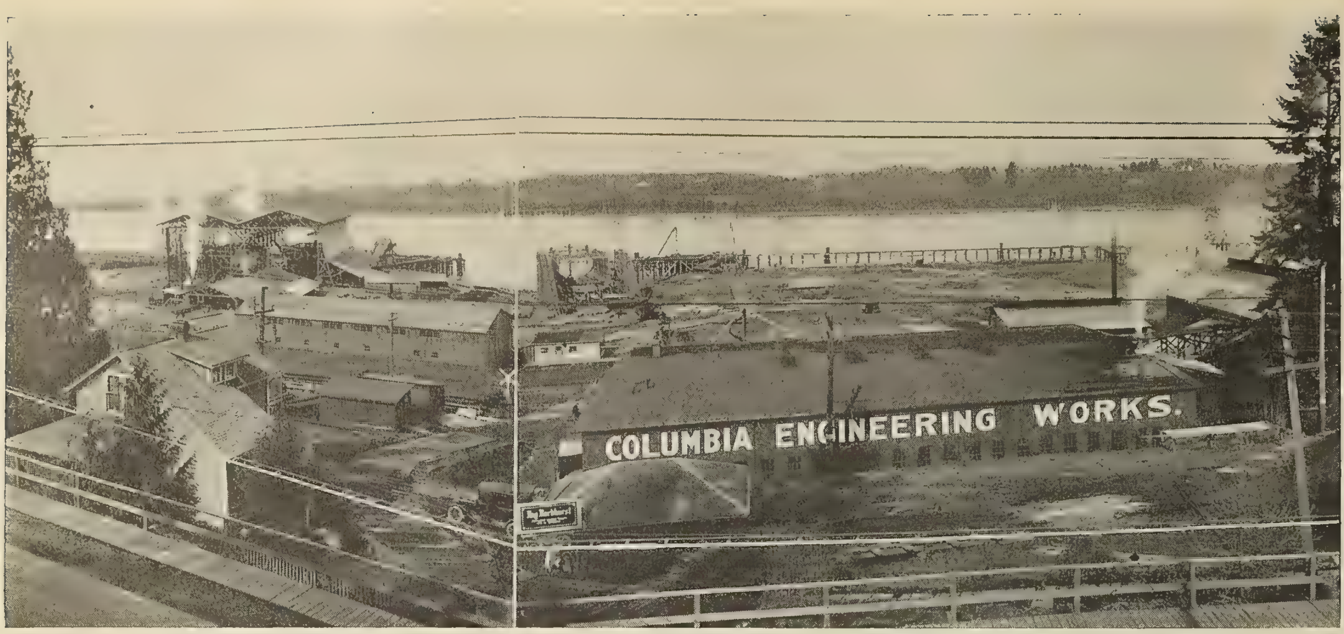


Fig. 1.—General View of Plant of Columbia Engineering Works, Portland, Ore.

Shipyard of Columbia Engineering Works

Fully-Equipped Plant for Building Wooden Ships at Portland, Ore.—Special Features in Design of Vessels Built

DUE to their advantageous location with respect to an unlimited supply of materials, favorable climate and an adequate labor market, shipbuilders and engineers on the northern Pacific Coast quickly took advantage of the extraordinary demand for vessel tonnage two years ago and immediately developed their resources for building ships. Among those manufacturers engaged in other lines of work, which showed their resourcefulness by promptly adapting their facilities to wooden shipbuilding, was the Columbia Engineering Works, Portland, Ore., of which S. M. Mears is president, and A. M. Mears general manager. Since October, 1916, this firm has been operating a fully equipped yard for building wooden vessels on the Willamette River, about five miles from the Columbia and within the city limits of Portland.

This yard has specialized in the construction of moderate size types of wooden sailing vessels, most of which have been equipped with auxiliary power consisting of a twin screw arrangement of the Diesel type marine internal combustion engines. Four vessels built by this firm are in service in the ore trade, two being sister ships 185 feet long, 36 feet beam and 16 feet 8 inches depth. The plant is now so organized that a complete vessel is being delivered every thirty days.

Auxiliary Power Installed

Four of the vessels built by this concern have been equipped with the Craig Diesel type engines, built by the James Craig Engine & Machine Works, Jersey City, N. J., two with Skandia oil engines and one with Wolverine engines. The total power in each vessel is about 400 horsepower, although in one case the engines were designed for 600 horsepower.

The Columbia shipyard covers 17 acres and has a water frontage of 1,000 feet. There are four shipways, two of which are under cover.

Fig. 2.—Launching at the Columbia Shipyard

Fig. 3.—Stern of Vessel Shows Graceful Lines of Hull

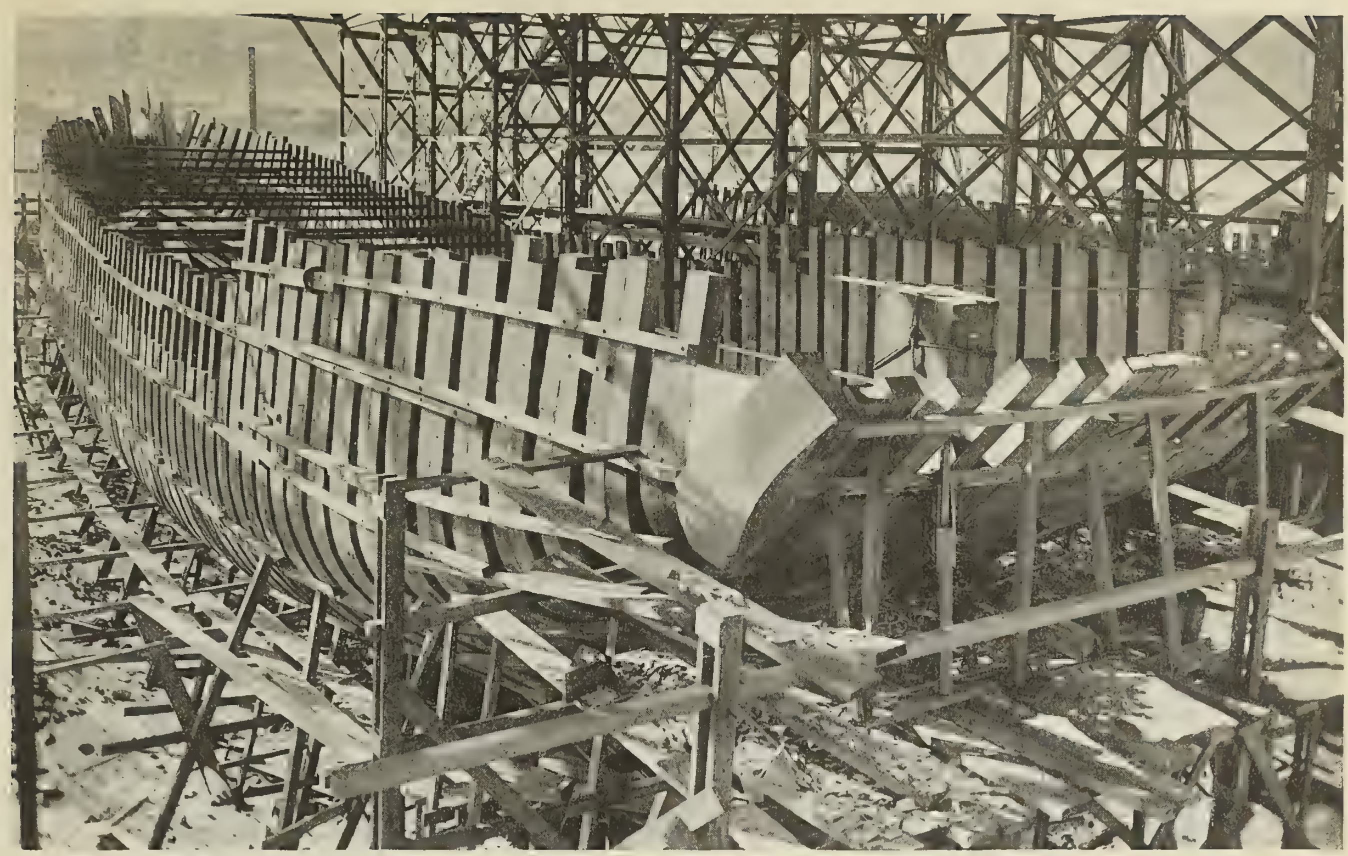


Fig. 4.—Vessel in Frame at Columbia Engineering Works

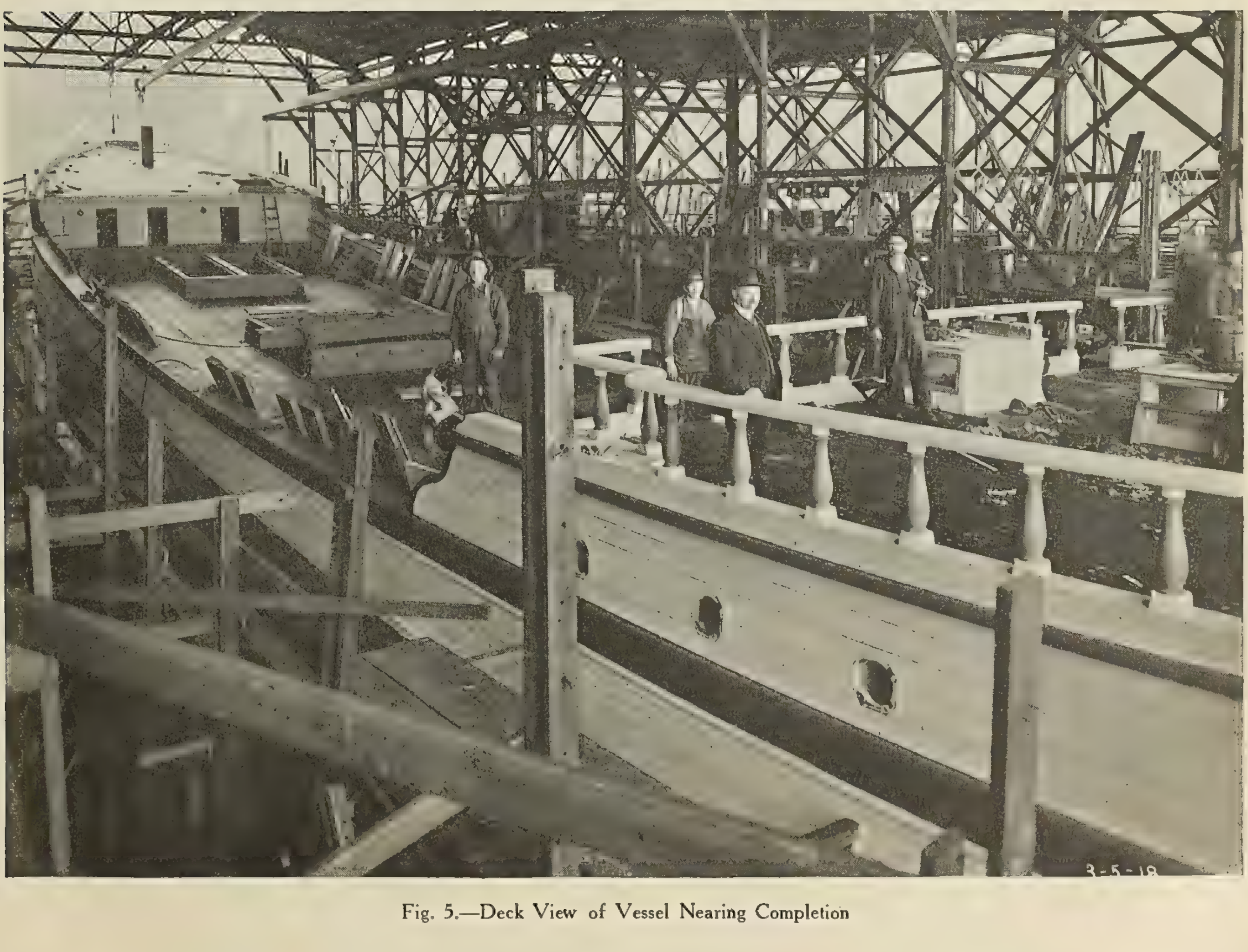


Fig. 5.—Deck View of Vessel Nearing Completion

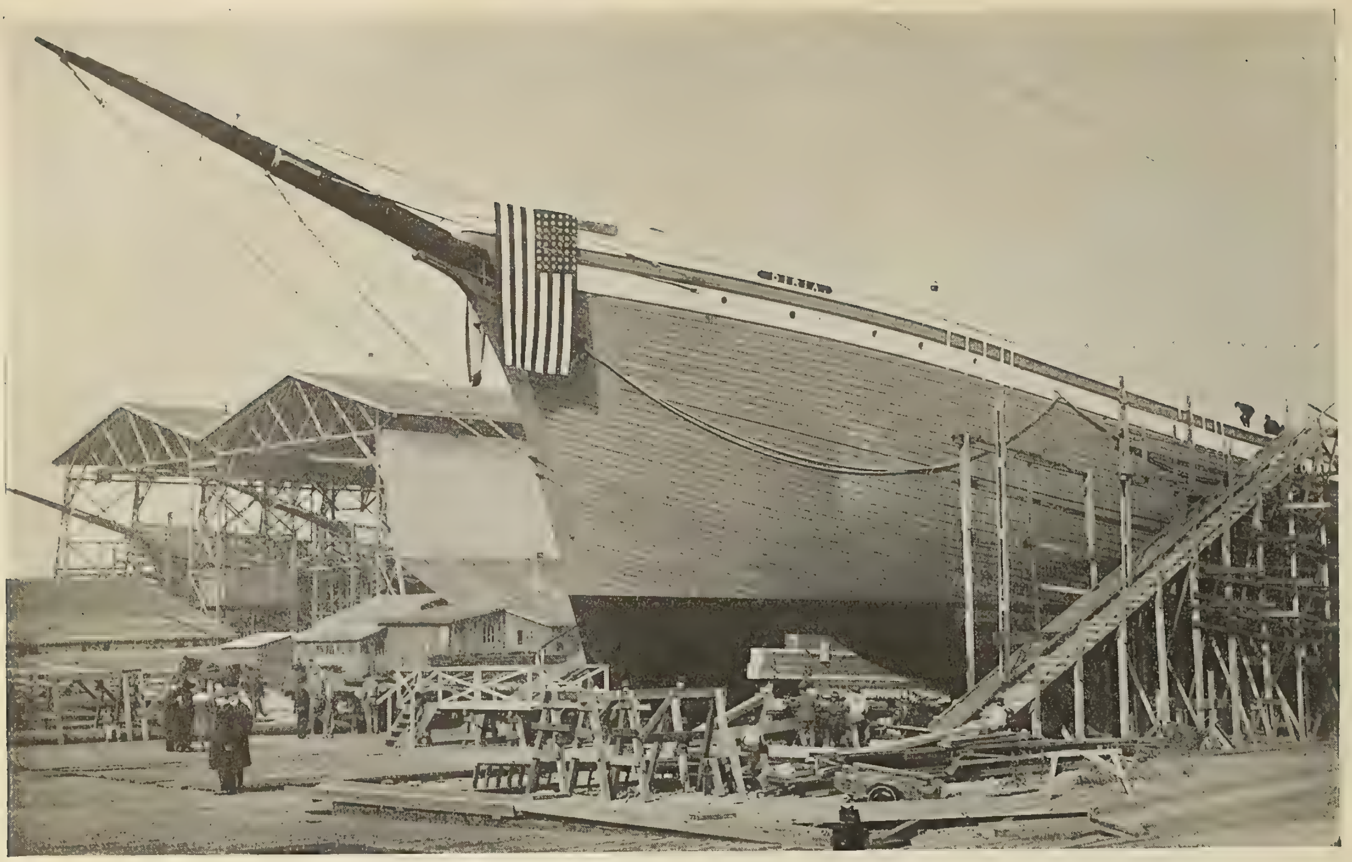


Fig. 6.—General View of Shipways

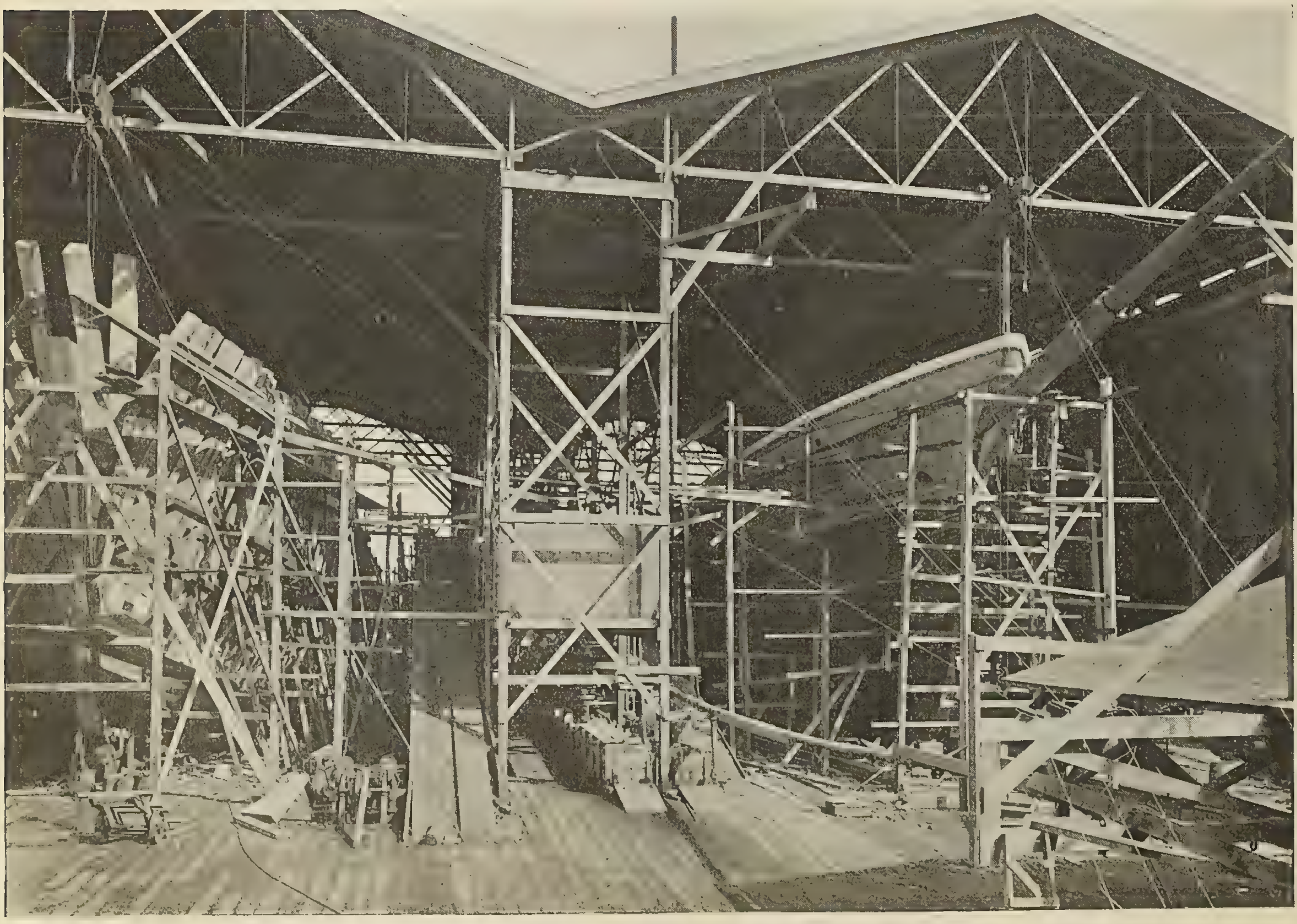


Fig. 7.—Covered Ways to Expedite Work in Winter Weather

Fig. 8.—Fabricating Yard and Saw Shed at Head of Shipways

Fig. 9.—Deck View of Finished Vessel, Looking Forward

Fig. 10.—Deck View, Looking Aft, Showing Cargo Winches

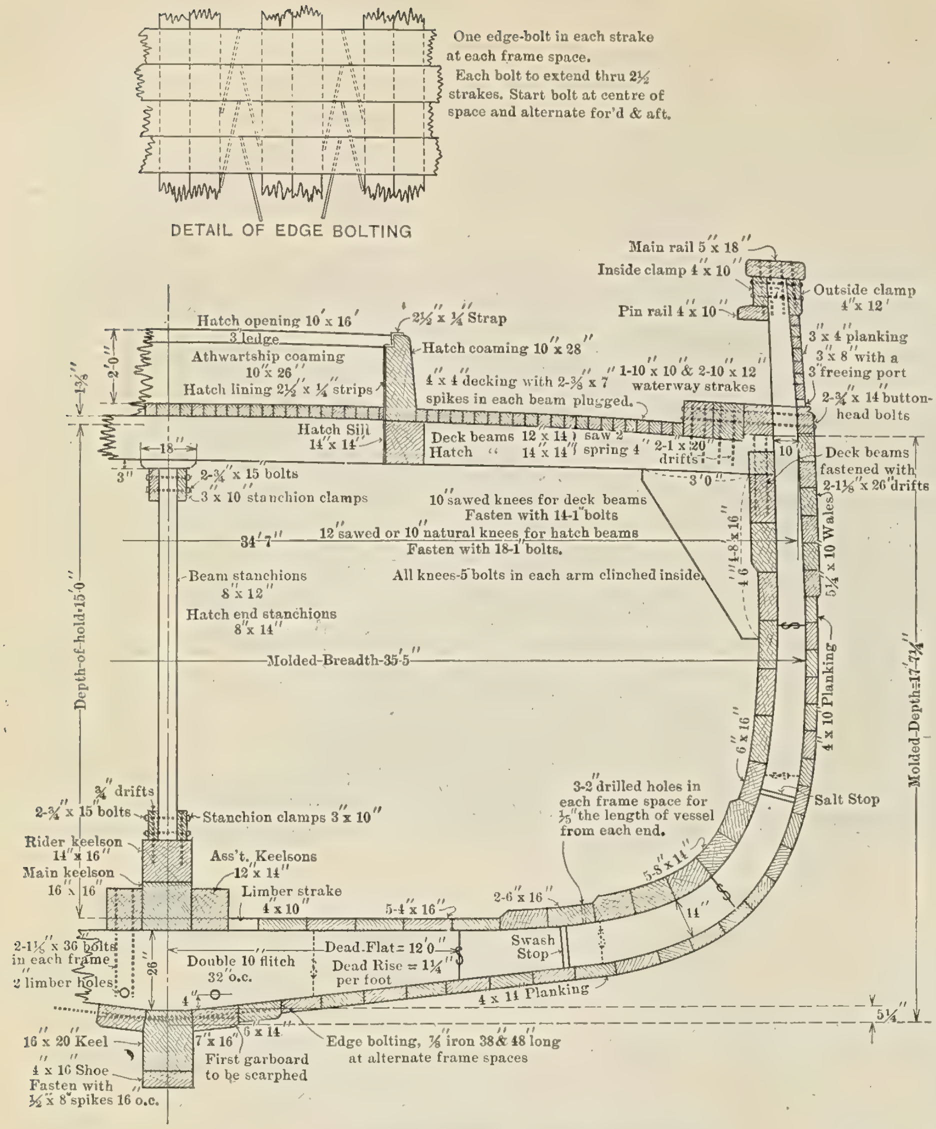


Fig. 11.—Midship Section of 184-Foot Vessel

Ordinarily, lumber is delivered to the yard by water, being rafted into an inclosed basin, whence it is lifted out of the water by a set of sheer legs operated by a donkey engine Material is also delivered by rail, as the yard is served by a branch from the Spokane, Portland and Seattle Railway, a branch of the Northern Pacific.

Equipment of the Yard

The yard is thoroughly equipped with machine, blacksmith and woodworking shops for manufacturing every part of the ships under construction, including the fittings, ship's tackle, steering gear, tanks, etc. The machine shop, shown in the foreground in the photograph, Fig. 1, is 130 feet long by 85 feet wide, with the main office and drafting room in an upper story at one end of the shop. The machine shop is equipped with six lathes, one with a 40-inch swing, milling machines, radial drill presses and other tools for manufacturing the ships' tackle, steering gear, turn buckles and other equipment.

Beyond the machine shop is a blacksmith shop, the equipment of which includes two 800-pound Niles-Bement-Pond steam hammers and five forge fires. The tank shop, 60 feet by 80 feet, with 25-foot head room, is equipped to handle plates up to ¾-inch thickness. The equipment of the tank shop includes a Bliss & Company double punch and shear, a Wangler bevel shear, a Badger splitting shear, a set of 8-foot Bertsch bending rolls, a Hanna bull riveter and Oxweld cutting and welding torches.

The mold loft, 50 feet by 120 feet, is located in a separate building. Underneath this is a storeroom for oakum, treenails and other supplies. At the head of the shipways is the main ship shed equipped with two ship saws, two band saws, one cut-off saw, a jointer, bevel planer and circular saw.

The tools throughout the plant are operated by either electric motors or compressed air. The capacity of the compressed air plant is 1,600 cubic feet per minute, and consists of four Ingersoll-Rand compressors, one of which is direct connected to a high-speed Steam engine, one Pratt steam-driven compressor and one Gardner compressor.

Shipways

The ship sheds are 55 feet height, 60 feet wide and 220 feet long. Under these covered ways the work can be carried on without interference during winter weather. All of the ways are served by overhead hoists of two tons capacity operated on cables. Power for operating one hoist is furnished by a Clyde three-drum reversible engine. At the fitting-out berth which is arranged for fitting out four vessels at a time, a set of sheer legs of 10 tons capacity is arranged for stepping masts and handling other heavy equipment.

Types of Vessels Built

As shown by the illustrations, the vessels built by the Columbia Engineering Works are for the most part schooner rigged, known as the Pacific Coast type, with commodious accommodations for the officers in the poop and for the crew in the forecastle. As a representative type here is shown in Fig. 12 the sail and deck plan, and in Fig. 13 the midship section of a four-masted auxiliary schooner 184 feet long between perpendiculars, 35 feet 5 inches beam, molded, and 17 feet 7¼ inches depth molded to the main deck.

The main scantlings are shown on the midship section, and comply with both Lloyd's and American Bureau requirements. It will be noted that the depth of floors at the keel is 26 inches. At first glance this may seem excessive when compared with other designs, but attention is called to the fact that the usual heavy keelsons and ceiling are dispensed with. The results obtained have been very satisfactory as reported by the owners and operators of these ships.

As the strength of a wooden structure depends upon the fastenings, especial attention has been given to this feature in the design of these vessels, so that the full strength of the timbers will be secured.

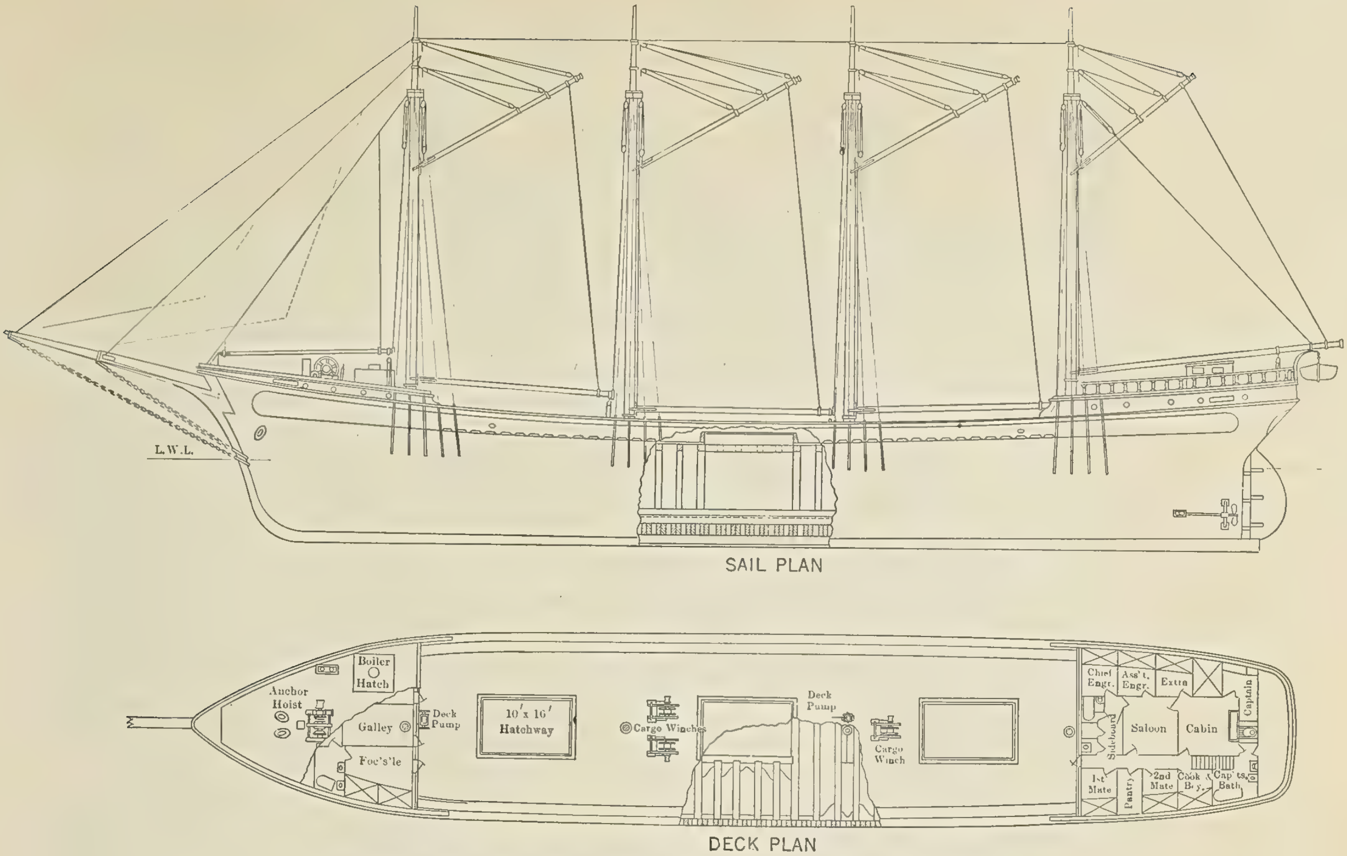


Fig. 12.—Sail and Deck Plan of Four-Mast Auxiliary Wooden Schooner

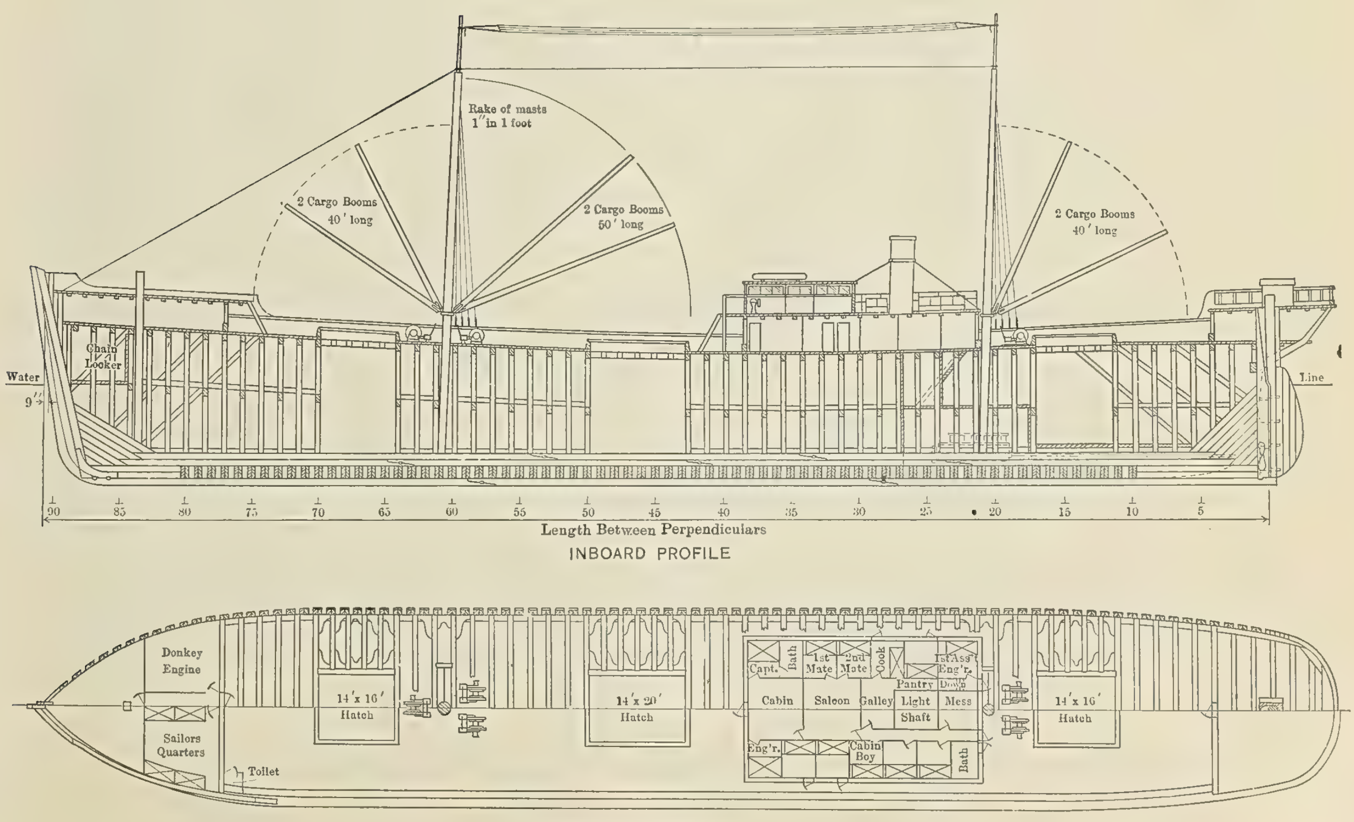


Fig. 13.—General Arrangement of Wooden Steamer

In discussing the design of wooden vessels, Mr. Arthur M. Mears, general manager of the Columbia Engineering Works, brings out the following interesting points:

It is a deplorable fact that many wooden ships have been improperly built, but that does not mean that a good and serviceable wooden ship is impossible to obtain at a reasonable cost.

If wooden ships were designed with as much care as steel ships failures would be very rare. In designing a steel structure, the joint is always considered the critical point, and the members selected accordingly. This holds true with a wooden structure as well, but it is very evident that most builders or designers fail to realize this, as is clearly shown by the fact that many ships are built with ceiling 10 inches to 12 inches in thickness and secured with edge bolts 1 inch to 1¼ inches diameter, 5 feet to 6 feet apart.

It is very easy to prove with figures, but quite self-evident, that with such fastenings the bolts would bend and the adjacent wood crush long before the total strength of the timber is reached. Not alone does the number and size of the bolts need to be examined, but the manner in which they are driven. The holding power of a bolt depends on the tightness with which it is driven, and will start with zero where the bolt is loose in the hole and increase until the wood is stressed past its elastic limit where the hole is too small. The Government has proved through extensive tests that it takes 50 percent more pressure to move a bolt contrary to the direction of driving than it took to drive the bolt. By the proper selection of the direction of driving considerable additional strength can be secured. The Government tests show that the maximum holding power of a 1-inch bolt per lineal inch is 2,500 pounds.

Weight of Material

In designing the structure of a ship there are three points which must be borne in mind: strength, cost and weight. The latter is often overlooked, but is very essential to the owner, as every extra ton of excess material used cuts down the carrying capacity and, therefore, the earning capacity of the ship. All parts should be relatively equal in strength as nearly as possible, but weight can also often be reduced by variations in design or placing of members. For example, the strength of a timber varies as to its sectional modulus $\frac{b\,h^2}{6}$, therefore a 10-inch by 24-inch flitch timber can be used in lieu of 12-inch by 22-inch, with a saving of about 10 percent in weight.

Possibly much of the trouble is caused by following blindly the old rules of the classification societies, which have not been revised for many years.

A vessel must be considered as a single member designed to withstand a certain maximum load, and its strength will vary as the square of the depth, other things being equal. Therefore, the rules of the societies based on tonnage alone give widely different relative strengths, and in the following rules one vessel might be of sufficient strength, while another one might be too weak.

Depth of Floors

The greatest difficulty experienced with wooden vessels has been with the floors coming up or "hogging," as it is sometimes called. There is such a variance in the design that it is evident that all designs cannot be correct. To show the variance, we give the tonnage of a few ships, with their depth of floors at keel. These are not freak ships, but have been designed by reputable firms of engineers:

Tonnage of Ship	Depth of Floors at Keel
2,200	24
3,500	18
3,500	26
2,600	26
2,200	30
3,000	18
2,800	24
2,400	15
1,200	26

By comparing the drawings of these vessels it is also evident that no account is taken of the location or shift of butts. With the ordinary design the butt is the critical point and should be the first point examined.

In many cases the double frames are not adequately fastened together, and the floor ceiling is only secured with spikes, which could easily give and allow the flitch to separate.

In lieu of sufficient transverse strength, many ships have excessive keelsons and heavy ceiling. These long keelson and ceiling timbers will bend and often break if picked up at their middle, so that it is impossible for them to keep the floors down. This is even more manifest when it is remembered that in the ordinary ship there are three or four of these long sticks end on, and they must be spliced together and bolted.

The reasons for the errors which are being made today are in nearly every case traceable to the change in conditions under which wooden ships are being built and to the following of rules intended for ships built of hard wood. There are many examples of wooden ships built of Douglas fir that have given many years of hard continuous service. One of the best examples of this was the old passenger and freight steamer *City of Mexico*.

Bending Frames For Wooden Ships

FREDERIC MERON, mechanical engineer, 2 Rector street, New York, has developed apparatus for heating and bending frames for wooden ships. In the first place, it is necessary to saturate the wood timbers by means of steam preparatory to subjecting the timbers to pressure for bending them to the required shape. Heretofore, this has been done mainly by subjecting the wooden timbers to high pressure steam in a sealed chest, or chamber, in which they were piled, one upon the other, with the result that the degree of saturation was not uniform over all of the timbers, nor over all of the parts of a single timber. Furthermore, with this method steam was wasted each time the steam box was opened for the removal of the timber, and the entire contents of the steam chest had to be removed before recharging the steam box.

Mr. Meron's invention is designed to obviate these difficulties and to afford a simple means whereby the process of saturation of the wooden timbers may be rendered continuous with the use of low pressure or exhaust steam, so that all sides of each piece are treated uniformly and effectively exposed to the moisture. With this apparatus the treatment given certain timbers may be varied to conform to the various requirements of the different grades or kinds of wood used or the purpose for which it is to be employed.

In addition to this, Mr. Meron has devised apparatus for the shaping of the wood after it is steam heated, so that the parts may be turned out in quantity.

Safety and Relief Valves—II

Special Features of Valves for Saturated and Super-heated Steam—Piping Arrangement—Testing Pop Valves

BY M. W. LINK*

THE question of the amount of piping allowable in the installation of a pop valve has been discussed in the technical papers since the advent of the pop valve. It is, however, of such importance that it should always be kept in mind when pop valves are installed.

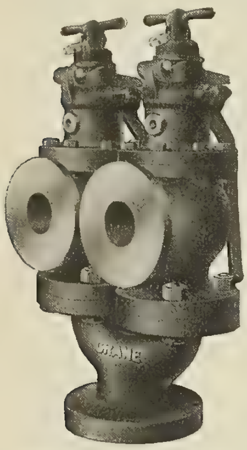


Fig. 4.—Twin Pops

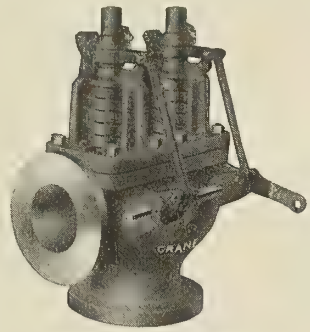


Fig. 5.—Duplex Pop

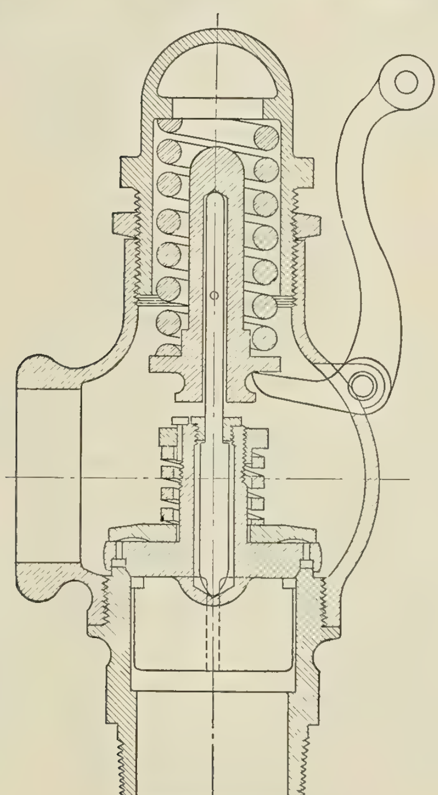


Fig. 6.—Brass Marine Pop Valve

Briefly stated, for a general rule, no pop valve should be installed with any pipe between the boiler and the pop valve, except *when the pipe is two pipe sizes larger than the valve* and the length of this pipe is less than 24 inches.

On account of the objectionable noise created by the escape of steam from a pop valve and also to conserve steam, it is customary to pipe the outlet of pop valves. On

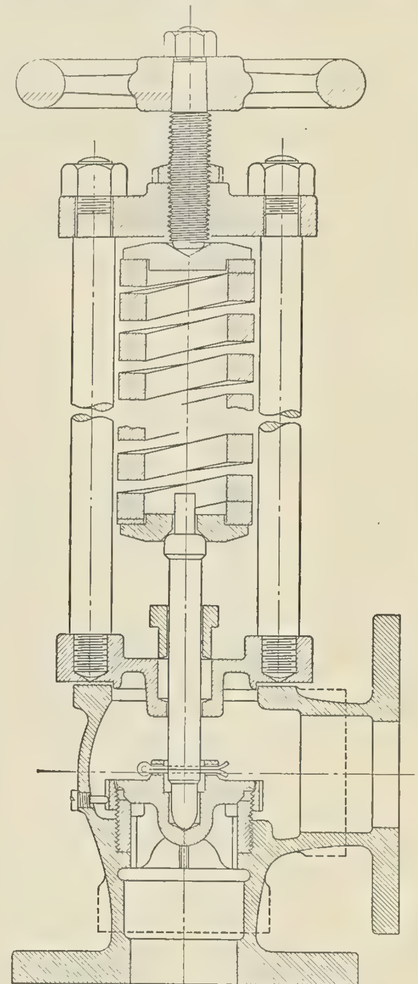


Fig. 7.—Water Relief Valve

the ordinary type of encased inside spring pop this piping is allowable within reason. On any inside spring type of valve this piping is an objection unless considerable judgment is used in the exhaust piping, etc.

The successful operation of a pop valve with and without piping in the *outlet* is due to the prevention of the accumulation of a back pressure in the body of the valve above the main disk. In the encased spring type of valve this back pressure usually cannot set up any detrimental action on the disk and spring.

In the inside spring type of valve, this back pressure changes the result of the action of both the spring and the huddling chamber, to such an extent that the valve will chatter and tend to cause the blow-back of the valve to alter with every pop.

The successful operation of a pop valve, when piping is used between the *boiler and the inlet of the valve,* is due

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to the prevention of any drop in pressure in the inlet piping by the use of large pipe.

As the velocity of the steam in this pipe would, ordinarily, be extremely high, the drop in steam pressure, due to resistance, would also be high, causing an earlier closing of the pop than desired, thereby producing chatter of the pop disk.

On any high lift valve it is necessary to place the valve directly upon the boiler or on a properly designed base and also to increase the outlet piping one pipe size to prevent chatter.

Superheated Steam

Safety valves for this service should be of the direct spring loaded pop type and have steel bodies and yokes. The seat and disk should be of a nickel alloy, having the

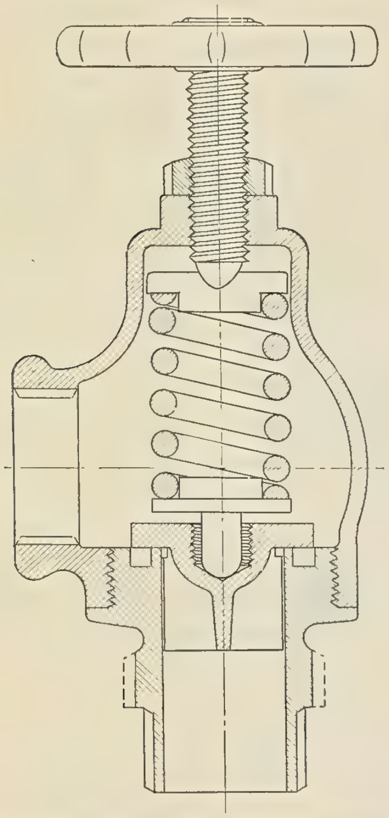


Fig. 8.—Brass Relief Valve for Hot Water

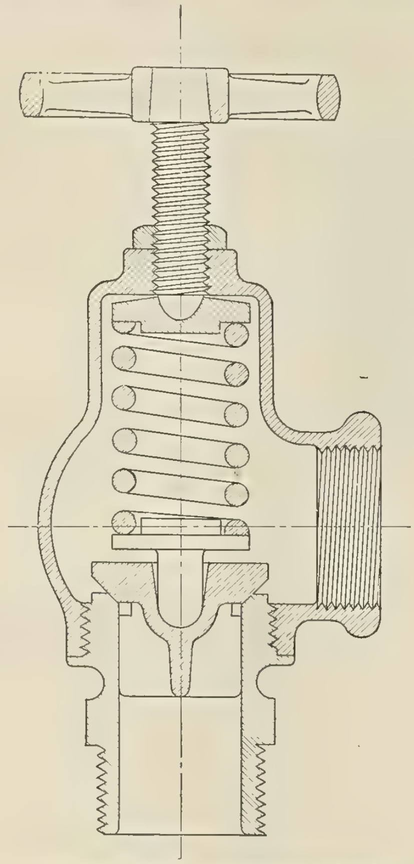


Fig. 9.—Brass Oil and Water Relief Valve

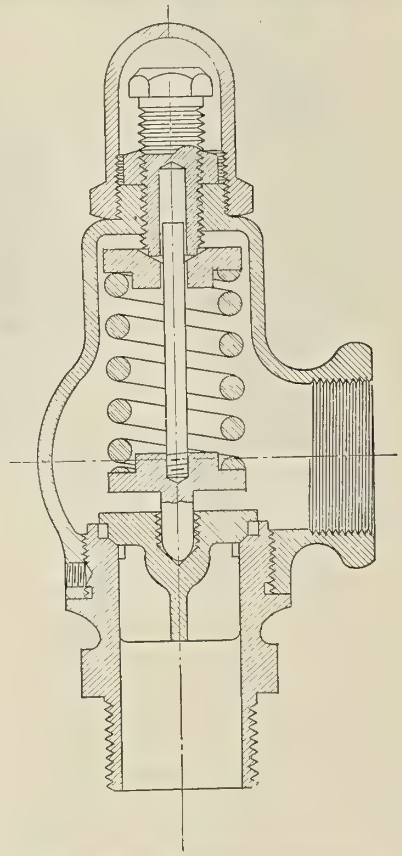


Fig. 10.—Brass Cylinder Relief Valve

same coefficient of expansion as cast steel. Monel metal is the ideal metal for this service. The springs on these valves should be of the outside exposed type, and should also be protected from the disturbing effects of escaping steam. The springs should be crucible steel, drawn at a temperature of not less than 600 degrees F.

The stem should be of drop forged steel, with a seating point on bevel seat valves below the valve seat. See Fig. 12.

The disk should be connected to the stem so that by raising the outside lever the disk will be lifted from its seat.

Saturated Steam

Safety valves for this service, on boilers, are invariably of the twin or duplex type. Valves should be of the direct spring loaded pop type. Bodies and bonnets to be of high grade cast iron, semi-steel or cast steel. The seat and disk to be of high grade brass; some prefer seats of a nickel-alloy, which seems to stand up better on the higher pressures.

Springs may be of the outside type, which are to be preferred on pressures above 175 pounds. If springs are of the inside type, they should be encased; i. e., free from the disturbing action of the escaping steam and also to prevent the back pressure in the valve piping from interfering with the working of the valve. This back pressure is the result of marine practice requiring the piping up of the outlet of the safety valve.

Twin valves, that is, two single safety valves mounted on a twin base, are the safest and best type to use, but, owing to the extreme head room required and extra flanged joints, are not always used. The advantages of having two independent valves should offset the disadvantages quoted above, whenever it is possible to use the twin pattern. See Fig. 4.

Duplex valves, that is, two sets of trimmings in one body, are the most popular for marine service. By their use there is but one joint between the boiler and the safety valve. Head room is reduced to a minimum.

The design, however, presents some inherent difficulties. Great care must be taken in the design of the body so that casting strains do not cause distortion of the seats. The seats must be so placed to prevent leakage due to strains set up by the changes in boiler shell (Scotch marine type of boilers). Piping connections on the outlet of the boiler must be carefully made and anchored to prevent distortion of the valve body. Broadly speaking, the duplex type must be treated with more consideration to prevent leakage, etc., than the twin type. See Fig. 5.

In the past, triplex and quadruplex pops were used, mostly with brass bodies. These types are being discarded because of the distortion strains and multiplicity of other difficulties. It certainly is a step in the right direction to eliminate the triplex pop.

The spring and disk of all steam pop valves should be connected so that the disk may be raised from its seat by lifting the outside lever of the valve. The springs

should be of such length and design that the disk may be raised from its seat by the outside lever 1/8 of the valve diameter when there is 75 percent of the popping pressure in the boiler. Valves for Lloyd's requirements must be arranged so that the disk may be reground by turning the stem from the outside of the valve, which, by the way, helps ruin the seat bearing. A further Lloyd's rule calls for a device which, when the valve is locked and sealed, prevents the spring from being compressed beyond the original set pressure.

Brass Pop Valves for Saturated Steam

The majority of valves used for this service are made with a male thread on the base. This is good practice and the use of flanged bases and bases with female threads should be avoided. Flanged bases in brass spring easily when being bolted into place. Female bases cause more leakage, due to the practice of using pipe cement on the pipe. This cement works into the valve at the first pop and usually stays long enough to ruin the bearing at the seat.

The general design of the brass pop should follow the iron as far as possible. The use of brass pops larger than 2 inches should be avoided. There is no advantage in their use and the initial expense is not compensated for the service rendered. See Fig. 6.

Relief Valves for Hot Water

For high pressure, the design shown in Fig. 7 has been found the most satisfactory.

For medium pressures and small sizes, the design shown in Fig. 8 is recommended. The blow-down with this type is usually about 10 percent of the set pressure.

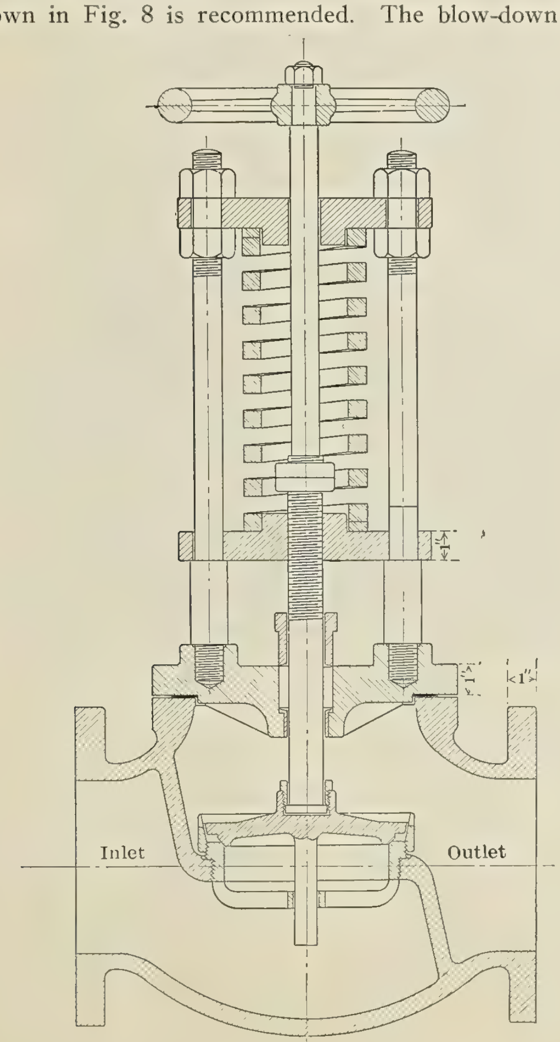


Fig. 11.—Safety Valve for Back Pressure Line

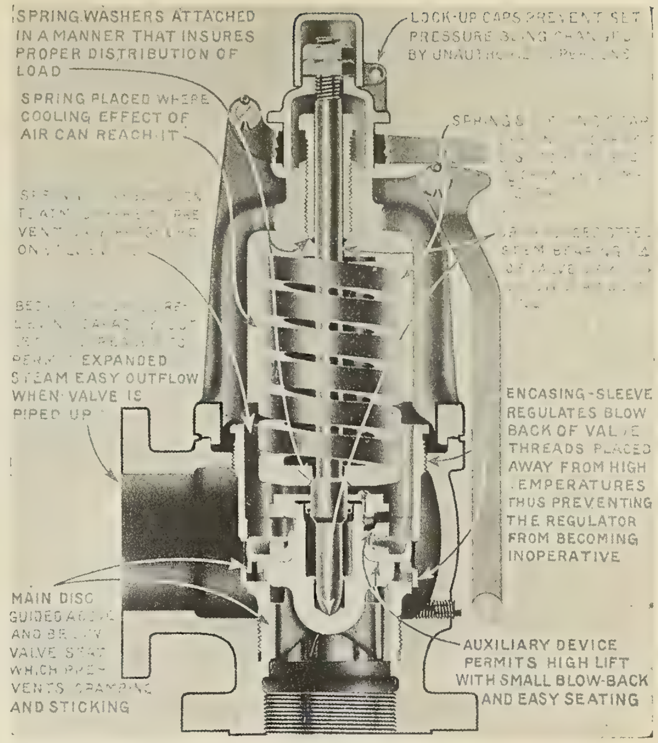


Fig. 12.—High Pressure, High Capacity Valve

For cold water and oil, design shown in Fig. 9, owing to its simplicity, is recommended. The blow-down is about 20 percent of the set pressure.

For snifting and cylinder relief valves, valves with the fewest number of parts are extremely important. Fig. 10 shows a design which has been in successful use for over 25 years.

Safety Valves for Back Pressure Lines

Fig. 11 shows a type of valve which is recommended for back pressure marine service. It contains all features necessary for successful operation:

1. Outside spring.
2. Handwheel control.
3. Stuffing box on "vacuum" side.
4. Adjustment to vary back pressure.
5. Huddling chamber to give popping action.
6. Indicator to designate what condition of valve may be applied.

The objections are high head-room, necessity for installation in a horizontal line and initial cost.

There is no better method of illustrating all the features of a design which make a successful high pressure, high capacity valve than that shown in Fig. 12. A 3-inch duplex valve shown in Fig. 5, having the design as shown in Fig. 12, has a discharging capacity of 26,500 pounds of steam per hour at 200 pounds boiler pressure and 3 percent over pressure rating.

Testing Pop Valves

A few hints may prove of value when testing any pop or relief valve.

1. Be sure your testing gage is correct.
2. See that your valve is clean—absolutely clean.
3. Test water valves with water.
4. Test steam valves with steam or air. (Not water.)
5. Thoroughly understand the valve you are testing.
6. When testing, have enough steam or water to meet

approximately the discharging capacity of the valve under test.

7.—Don't lift the disk of a steam pop from its seat when cold. Wait until the pop heats up.

8.—Always install safety and relief valves with the stem in a vertical position.

Highly Superheated Steam Used on Steamship Pearl Shell

THE bulk oil tank steamship *Pearl Shell*, owned by the Shell Oil Company, of California, is a recent production of the Harlan & Hollingsworth Corporation, Wilmington, Del. The vessel was launched in 1916, and is an excellent example of some of the more recent additions to the United States merchant marine. The principal dimensions are:

Length over all	411 feet 6 inches
Beam	53 feet 4 inches
Molded depth	29 feet 8 inches
Gross tonnage	5,845
Net tonnage	5,310

As is customary in vessels of this class, the machinery is located aft. Propulsion is by an inverted, direct-acting, triple-expansion, reciprocating engine of 2,400 horsepower, with cylinders 29 inches, 45 inches and 74 inches diameter, and 48-inch stroke. The high pressure cylinder, placed forward, is equipped with a piston valve having solid rings; the intermediate is in the middle and has a slide valve with M. & S. relief frame; the low pressure is aft and is fitted with a plain slide valve. The engine is designed to turn about 66 revolutions per minute at 65 percent cutoff. Copeland packing is used on the high pressure piston rod, and all piston rings are Lockwood & Carlisle.

Steam at 180 pounds pressure is supplied by three single-end Scotch boilers 15 feet 8 11/16 inches outside diameter and 11 feet 7 inches long, located two athwartship and one forward, all having a common stoke hold. Each boiler has three Morison corrugated furnaces and 358 3-inch outside diameter tubes, which provide an evaporating surface of 2,667 square feet, while the grate surface is 64.4 square feet. The stack is double, and is 8 feet 6 inches by 75 feet. The boilers are operated under Howden forced draft and are arranged to burn either coal or oil. Originally the fuel was coal, but at present oil is being used.

One of the most interesting features of the *Pearl Shell* is the use of highly superheated steam. The superheating of the steam is accomplished by means of a firetube superheater manufactured by the Locomotive Superheater Company, 30 Church street, New York. The arrangement of the superheater equipment is shown in Fig. 2. Each boiler has four cast steel headers or collectors. These are arranged in pairs, each pair having one saturated and one superheated header, and are connected by units of cold drawn, seamless, steel tubing, which extend into the boiler tubes. Each pair of units is attached to the headers by means of a clamp and stud, and may be released by removing a single nut. The units are of the continuous type, and have return bends formed integral from the tubing. The superheater is designed to provide steam at a temperature of 600 degrees F. at the throttle under normal operating conditions. Reports from the vessel indicate that this temperature can be maintained very closely.

Fig. 1.—S. S. *Pearl Shell*, Built by Harlan & Hollingsworth Corporation for Shell Oil Company of California

The use of highly superheated steam is becoming more and more general in marine practice as its advantages in fuel saving, increased power and speed and greater steaming radius from a given amount of fuel are recognized. There are now more than 2,200,000 horsepower of marine engines receiving highly superheated steam from superheaters of the firetube type, and large numbers of ships now under construction include firetube superheaters in their equipment.

The *Pearl Shell* is one of the vessels recently taken over by the United States Government.

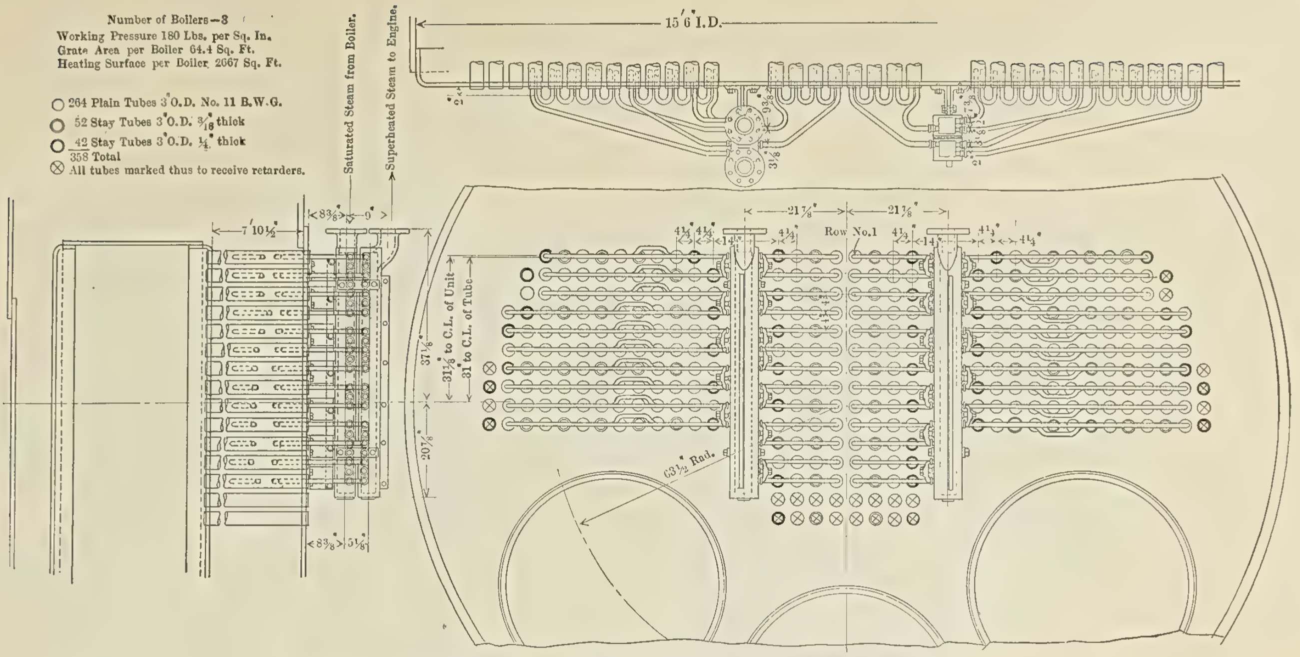


Fig. 2.—Arrangement of Superheaters on Boilers of S. S. *Pearl Shell*

New York Barge Canal Terminals

During the past year work has steadily progressed in completing the terminal dock walls and grading the sites at the various locations. On the majority of the up-State terminals temporary warehouses have been constructed, with the thought of accomplishing a double purpose, namely, to provide temporary facilities for handling freight and postpone the permanent construction until conditions in the labor and material markets are more favorable, and by the use of these temporary facilities to observe actually the results obtained at each terminal, since such information will be invaluable in planning the permanent work.

In Greater New York the construction of Barge canal terminals is in progress at the following locations: West Fifty third street, North River; Piers 5 and 6, East River; Greenpoint; 138th street, Harlem River, and Gowanus Bay. At this latter location there has been some discussion as to the possibility of constructing a grain elevator; but the State has never definitely committed itself to such construction. This site at Gowanus Bay is admirably located for elevator purposes. Knowing that the Federal Government would be called upon to make provision for sending oversea millions of bushels of grain to supply both our expeditionary forces and our Allies, the availability of this site for an elevator was brought to the Government's attention, and the State offered so to construct the pier now in process of building that, without interfering with its usefulness for general cargo-handling, it could also serve as a part of a 10,000,000-bushel elevator, which might easily be constructed on this site. No definite action has yet been taken by the Federal Government as to the construction of such an elevator.

During the past year considerable progress has been made in arriving at a settlement with the owners from whom property was appropriated in Greater New York for terminal purposes. Due, however, to the constant fluctuation in prices governing construction, it is not yet possible to arrive at any close estimate of the probable cost of development at the various sites now owned by the State. There is constantly being brought to the attention of the State Engineer sites which might be acquired and on which Barge Canal terminals could be constructed. In the majority of cases the locations suggested are susceptible of development and would be of benefit to the locality. The State is now the owner of waterfront property in Greater New York which will have been acquired as the result of the expenditure of a large sum of money. To ever realize on the investment the State must develop this property, and such is the present policy of the State in the matter. Until the work has further advanced and a closer estimate can be made of the ultimate cost of such development, the State is hardly in a position to obligate itself to construct additional terminals for which the sites have not been acquired. In arriving at this conclusion the fact has never been lost sight of that no provision for constructing terminals has been made for many sections of Greater New York where such construction is justified.

I am still of the opinion that the terminals are vital to the success of the canals, and I am bending every effort so to plan and construct them that on their completion they will efficiently and economically serve the needs of traffic and the requirements of shippers. It is certain that when they do demonstrate their value further appropriations must be made, not only to increase the equipment on those already provided, but to build additional ones.—*From annual report of New York State Engineer.*

It is a wise man who cuts in a valve between the boiler and the "blow." It will save much trouble and perhaps a life. Why this is not always done when the ship is building is difficult to understand, as it would then cost little. There is room for improvement in the construction of blow-off cocks, and greater attention should be paid to locating them so that they can be more conveniently reached.

In very highly rotative machines ring oilers sometimes do not act satisfactorily, as centrifugal action throws the oil from the ring. This trouble can be entirely averted by cutting a groove on the inside of the ring; in fact, this idea is an advantage if used in all ring oilers.

Letters from Marine Engineers

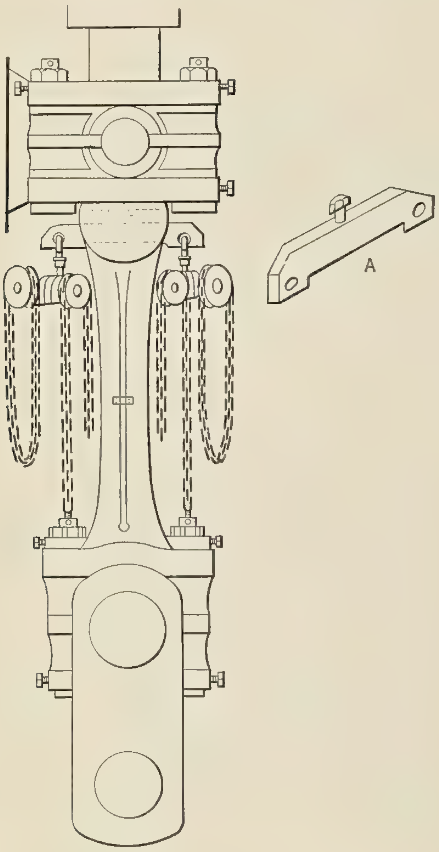
Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Chain Falls Strongback

Perhaps a sketch of the form of strongback used for rigging up the chain falls while overhauling main engine crank pin brasses may help others to more easily understand the best way to rig up heavy falls for such work on open-forked connecting rods.

The sketch is self-explanatory, but a word may make it clearer. The strongback is made of ⅞- by 4-inch plate steel, cut as shown in the small sketch *A*. A ⅝-inch



Method of Lifting Crank Pin Brasses

screw is used in the center. The strongback is put in, or saddles the center of the fork of the connecting rod, and the screw is then unscrewed out of the strongback until it meets the bottom of the piston rod or crosshead. This clamps the device in place, and the falls are hooked into the holes as shown.

Single chain falls with special eye bolts are best for the work. These permit the lowering of the brass without making a shift as when using special slings, etc. It is hoped that others will find these notes useful and the writer will appreciate suggestions from others.

O. N. Watch.

Planer Clamps

Two somewhat odd, but useful, types of planer clamps that can be forged up and machined easily by the ship's force are shown in the sketches.

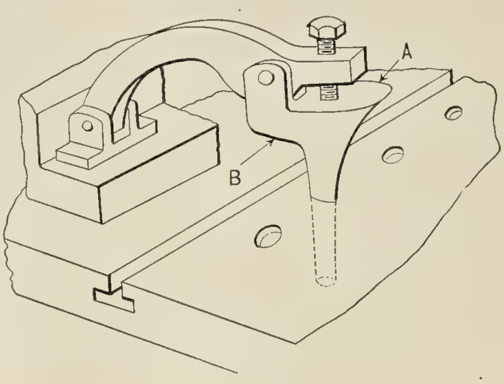


Fig. 1

The type in Fig. 1 is held fast by the fit of the taper leg in the hole by tapping at *A*. When necessary to shift it by prying up at *B*, it is readily removed

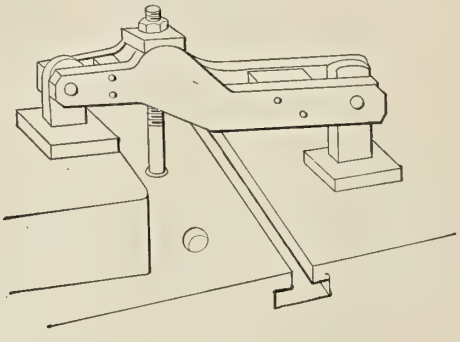


Fig. 2

Hardly any description as to the construction of either clamp seems necessary, for the sketches talk best. The clamps are made in sizes to suit the maker, therefore no dimensions are given.

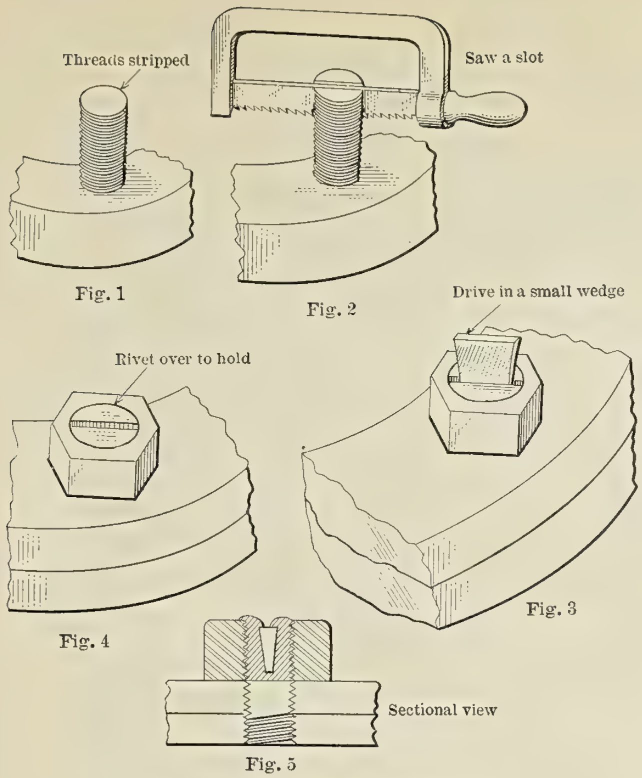
Chief Machinist.

A Few Wrinkles

Here are a few more wrinkles, or kinks, that the writer has added to the pages of his note book, and that may be deemed by other readers of Marine Engineering worth collecting for their use. The sketches are rather rough, but they serve to convey the ideas more clearly than words.

Figs. 1 to 5 show how to get around the disagreeable job of repairing a stripped stud. We all know what a mean job it is to have to take one out that is frozen in; then again, it is not always likely that we may have a new stud of the same size. There are many other reasons that the scheme shown may be welcome when one meets up with a stripped stud.

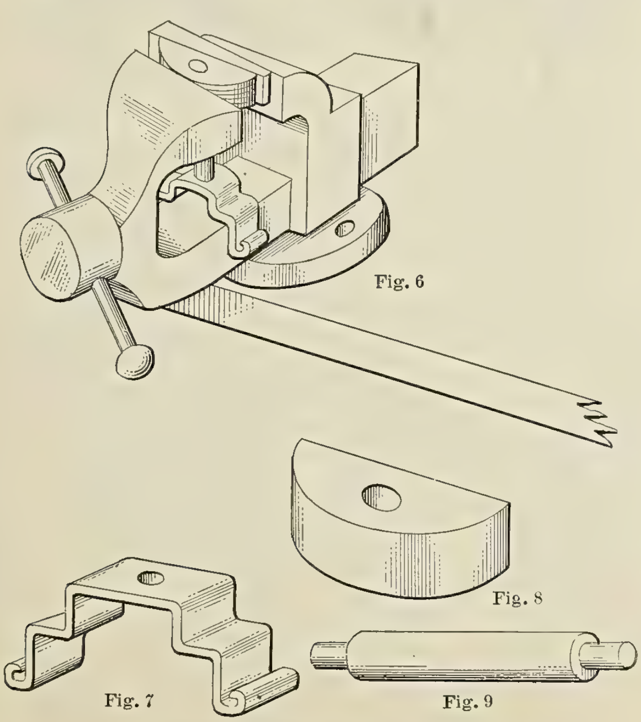
The attachment for a solid jaw vise shown in Figs. 6 to



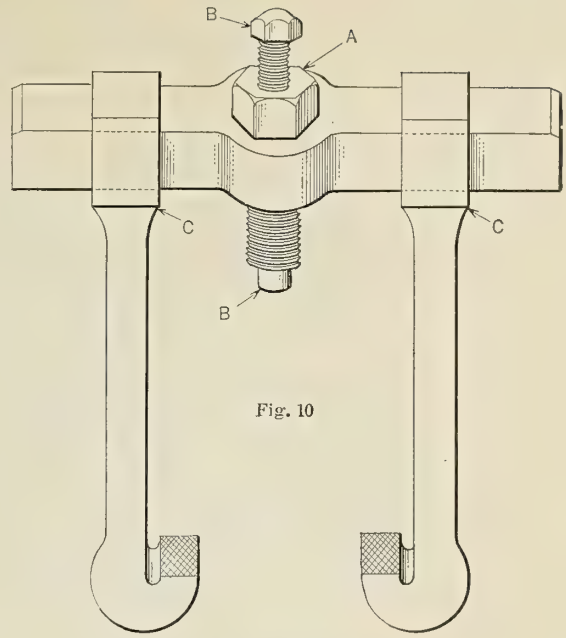
Emergency Repairs to Stripped Stud

9 is very simple and easy to make, and those who are not fortunate in having a swivel back jaw to their vise will welcome this wrinkle.

The gear, pulley, or fly-wheel puller shown in Fig. 10 is the best thing yet that I have ever come across for this business. We had to remove the vane impeller wheel from the shaft of our main circulator a while ago, and, after trying several of the old strap and bolt schemes with poor success, one of the oilers handed out this idea of a double screw in the center of the yoke; the idea, of course, being to prevent the bending of the screw. A large screw



Attachment for Solid Jaw Vise



Pulley and Fly-Wheel Puller

A was made, drilled and tapped to take another screw of smaller size through its center, as indicated at *B*. To use the puller, the arms *C* are put in place, and the large screw *A* used to start the impeller or fly-wheel off. This screw is used to pull the first and stiffest part of the work; the smaller screw *B* is used to pull the wheel off the remaining distance. This type of puller is a jim-dandy and easy to construct. Make all its parts rugged and of good steel.

Concord, N. H. C. H. Willey.

Adjusting Marine Engine Bearings*

BY WILLIAM M. MC ROBERT

One of the most important of the many duties of a marine engineer is the adjustment of the main engine bearings. To engineers who have operated on lake or river steamers it might be said that running an engine on the ocean is a little different from operating on inland

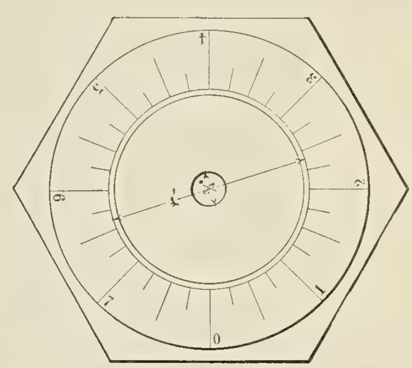


Fig. 1.—Nut Marked to Facilitate Adjustment

waters, for it is the practice on fresh water to allow a stream of water to flow continuously on most of the bearings to avoid overheating and to reduce the amount of lubricating oil used. This cannot be done at sea, as the salt and other solid matter in the water would ruin the bearing in a short time, so that dependence is on oil alone.

When an engineer joins a ship with which he is un-

* From *Power*.

familiar, he should, in order to avoid trouble while on a voyage, examine and adjust all the main bearings and the crank and crosshead brasses. When proceeding to adjust a bearing and before taking off the nuts, they should be marked so that their respective positions may be known and the amount, if any, taken up in adjustment determined. To make the nuts readily distinguishable they should be typed *P* for port and *S* for starboard, together with the number of the particular bearing to which they belong. The nuts on No. 1 bearing would therefore be designated as *P*1 *S*1, for when looking toward the bow of the vessel the side to the left is known as port and to the right is starboard.

A simple and permanent method of marking the nuts so that mistakes in adjustments are practically eliminated is shown in Fig. 1. Prior to slackening back a nut cut an arrow on the bolt with a thin, sharp chisel and make a light mark on the nut to coincide with it. Next remove the nut to the vise and graduate off somewhat as shown, using the mark already made for the zero or starting point. A piece of wood is necessary as a center for the nut when laying off the graduations with a pair of compasses and a sharp, flat chisel.

The arrow on the bolt will be used as the base from which all readings are taken, and a record of the position of each nut should be kept for reference in a manner similar to the following:

S. S. .... At Port of .... Date......

MAIN BEARINGS

	Port Nuts Adjustment		Starboard Nuts Adjustment	
No. 1	Before....4½	After....4¾	Before....6¼	After....6½
No. 2	Before....5	After....5½	Before....2½	After....3
No. 3	Before....6	After....6¼	Before....3¾	After....4¼
No. 4	Before....1½	After....1⅝	Before....5¼	After....5⅞
No. 5	Before....3¼	After....3¾	Before....4½	After....5
No. 6	Before....2½	After....2¾	Before....6½	After....7

All bearings including the crank bearings should have the same kind of record.

Having marked and removed the nuts from the bolts on one of the main bearings, for example, the engineer lifts the cap clear of the journal by means of a chain or rope block, then lifts off the liners, noting down their number and description so as to replace them after cleaning thoroughly. In marine work soft lead wire is generally used to ascertain the clearance between the wearing surfaces. To do this, take two pieces of wire and place one, circumferentially, on each end of the journal within two or three inches of the ends of the bearing surface. On a large engine three "leads" should be used, the additional one at the center of the bearing. Care must be taken that the wire is a little shorter than the exposed part of the shaft or the ends will get on top of the liners when the cap is put on. Making sure the leads are in their proper positions (a little soap or grease will keep them in place), lower the bearing cap, put the nuts on and tighten them simultaneously until they are at their respective marks or perhaps a little past them, until the cap is "solid" on its liners. Notice particularly whether the cap is solidly down on the liners; if not, insert an extra liner to make it so. Again mark and slack off the nuts and lift the bearing cap and gage the leads for thickness and the uniformity to which they are squeezed out. Any desired adjustments may be made by removing or adding liners as occasion demands. Next comes the connecting rod alinement and the adjustment of crank and crosshead bearings, referring to Fig. 2.

Every steamship engine is equipped with either a steam- or hand-operated turning engine for the purpose of setting the engine in any required position to effect repairs. Prior to moving the engine, take a look over the stern of the ship to see that there are no boats or ropes near the propeller, and also be sure that the engine itself is clear of obstructions; then by means of the turning engine put the high pressure crank on the top center. On the face of the crosshead-shoe guide will be found two tapped holes, to which a piece of plate or a casting may be attached to support the piston and connecting rod when the rod is disconnected from its crankpin. After this "guide plate," as it is called, is securely bolted in place, attach to each side of the crosshead a differential chain block. Mark the position of the crank bolt nuts, as in the case of the main bearings, then slacken them back after screwing an eye bolt firmly into the threaded holes in the ends of each of

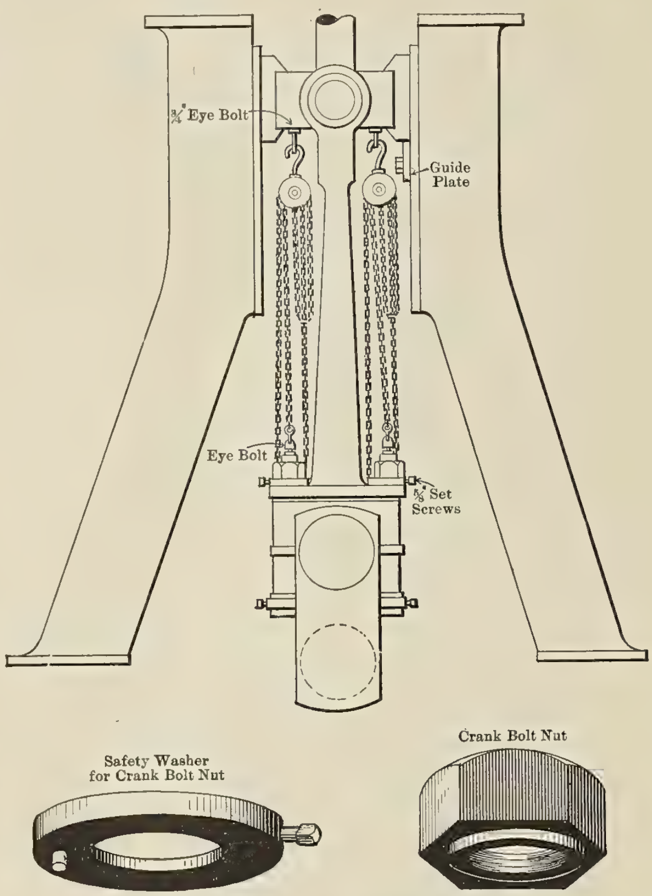


Fig. 2.—Unshipping a Crankpin Bearing

the connecting rod bolts and pulling up slightly with the two chain blocks; next lower the bottom half of the bearing gently on both tackles until it rests in the crank pit. The eye bolts and also the hooks on the chain block are small enough to pass through the bolt holes so the lower half can be lowered into the crank pit, or in case of small engines a rope sling may be used from the eye bolt to the hook. A rope sling is sometimes used in place of the eye bolts to support the chain blocks at the crosshead. With the turning engine turn the crank slightly ahead until the crankpin is just clear of the top half of the bearing, first making sure that the latter is held in place with a capscrew passed through each of the flanges. Keep the bearing off the crankpin, and with a pair of inside calipers measure to see if the end of the connecting rod is hanging central between the webs of the crank. In order to obtain smooth running, this condition must be realized.

Should the connecting rod be out of alinement, it may be corrected by inserting a thin liner between the lower crosshead brass and the top end of the connecting rod. Pounding might be overcome in many engines if the rods were put in line. It is sometimes necessary to scrape the

babbitt metal of the bearings in order to get a true alinement, but, no matter what is called for, the engineer can rest assured that continual trouble will ensue as long as the connecting rod is out of alinement.

On a 12,000-horsepower quadruple expansion engine the writer sailed with he spent many a hard day in tropical climates scraping the bearings to put the high pressure rod in line; in fact, on every available opportunity the chief had him on this job, but eventually success and comfort were the reward.

If the rod is found to be in line, turn the engine back until the crank is on its exact top center, and take off the guide plate and remove the cap bolts from the top half of the connecting rod bearing; then raise the lower bearing out of the crank pit until the bolts have just entered the holes, then carefully place two or three pieces of lead wire circumferentially at equal intervals along the surface as described for the main bearing; then pull the bearing or cap up into position and tighten the nuts to their previously located marks. Again slacken back the nuts and lower the bottom half of the bearing just so the leads can be removed. If they are the right thickness, clean the bearing thoroughly and pour a little clean oil on the surface; then heave up and pull the nuts solidly up to their marks, using a hammer on the wrench and being certain as before that the bearing is up solid on the liners. The intermediate pressure and low pressure engines are adjusted in turn in the same manner as described.

The foregoing is intended as a mere outline on the subject of the adjustment of marine engine bearings, all of which is familiar to seagoing engineers; but there are three important points to be remembered which should be emphasized, namely, before turning the engine see that the propeller is clear; that the guide plate is off and that all other obstructions are removed.

Fire on Motorship Sebastian Not Caused by Hot Exhaust Pipe

With reference to the article on page 137 of the March issue, written by Ensign Z. W. Wickes, entitled "Precaution Against a Fire on Diesel-Engined Ship," apparently Ensign Wickes is not thoroughly familiar with the case of the fire on board motor vessel *Sebastian,* to which he refers.

In the first place, he states that the fuel oil came in contact with the hot exhaust pipe of the main engine, which ignited the oil. But I would like to make it clear that the pouring of fuel oil on the hot exhaust pipes would not cause flames, and, furthermore, the exhaust pipes in question were properly lagged.

After making careful investigation, I have come to the conclusion that there was some foul play in connection with the fire. Perhaps a few details as to the fire will be of interest:

It appears that the chief engineer, when in his cabin, noticed by the sound that one of the engines had stopped and that the other was slowing down. So he quickly went below and noticed that the fuel oil had started to overflow from the filter, which is mounted on a grating over the engines, the fuel supply bottles that are suspended on a balance having run dry (probably due to a chokage between the filter and the reservoir supply bottles). The fuel supply bottles, running dry, of course, stopped and slowed down the engines respectively. Suddenly there was a tremendous flash of flame and the entire engine room was on fire, the fire instantly spreading right across in a big blaze.

Now, the engine exhaust pipes and the short extensions to each cylinder head were lagged with asbestos, with the exception of three expansion joints on the exhaust pipes and the flanges connecting the extensions to the cylinders.

This fully indicates that the fire had absolutely nothing to do with the Diesel engines, because the exhaust temperature could not possibly have been sufficiently hot to ignite fuel oil, and nowhere could there have been an exposed flame from the engines. To us it seems that there must have been some enemy plot that was arranged either before the ship left port or while the ship was at sea. Probably some highly inflammable chemical or gasoline (petrol) was mixed with the fuel oil before or after it was put in the bunkers. That the fire should have extended all over the engine room adds to the mystery.

"The remarkable thing," said the chief engineer, "was the entire suddenness and extent of the blaze."

The mean temperature of the exhaust gases of the *Sebastian's* engines under normal full load conditions is about 700 degrees F., whereas when the accident occurred one engine had stopped, owing to a stoppage of the fuel supply, and the other had slowed down, so that the exhaust gas temperature must have been very low when the fire started. There was no electrical sparking device on the engines to start a fire.

Mr. Arthur West, of the Bethlehem Steel Company, since has made some tests with a high powered gas engine at their works. While the engine was running at a big overload and with high exhaust temperature, fuel oil of 33 degrees Baume at 75 degrees F. (solar oil was the residual fuel used by the *Sebastian*) was poured over the naked, uncooled exhaust pipes; close to the cylinders, but under no circumstances could they produce a flame, just a smoke, that's all! Kerosene (paraffin) then was tried, with exactly the same results.

Now, this test was very severe, as it was made with an engine running at an overload and without an asbestos-covered or water cooled exhaust pipe, so it is obvious that the residual-oil fuel known as "solar-oil," running on to the exhaust pipe, or any other part of the *Sebastian's* engines, could not have caused a fire, and so supports our theory of a plot. No engineer of common sense would consequently blame the Diesel principle as the cause of the fire. T. Orchard Lisle.

New York.

Steam Tables for Condenser Work

The Wheeler Condenser & Engineering Company, Carteret, N. J., announce that the fourth edition of their handbook entitled "Steam Tables for Condenser Work" is now off the press, making a total of 20,000 copies.

One reason why this handbook has met with such success is that the pressures below atmosphere are expressed in inches of mercury referred to a 30-inch barometer. Another is that it is complete. It includes a discussion of the mercury column, the errors in such measurements, and constants for their correction.

A complimentary copy of the handbook will be furnished on request to those in responsible positions who are not yet provided with a copy and who deal with steam and its many problems.

Trams get lost, bent or broken. It is a mighty good plan to center punch the length of trams on some part of the engine and label it by stamping what they are for between the punch marks, as these records cannot get lost and are always correct.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY H. A. EVERETT*

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number if from examination for grade of chief, and by a dagger (†) if from examination for other grades.

Boiler Proportions

Q. (959).—Given an order for a Scotch boiler of the following particulars: Diameter, 12 feet 6 inches; length, 17 feet; double ended; six furnaces; 180 pounds steam pressure, how do you determine the diameter of the furnaces, the height of the waterline and top row of tubes above the center of the boiler, the depth of the combustion chamber, front to back, with furnace openings from one or both ends of the boiler, the proportions of the tube area to the furnace diameter, as, for example, how many 3-inch tubes should be used with a 36-inch furnace; also the area and spacing of staytubes? How much heating surface should be provided in a boiler of this size?

A. (959).—The following represents good practice for a unit of the dimensions mentioned, but this is a poor way to design a boiler:

a. Diameter of furnaces for 180 pounds pressure = 36 inches. Thickness of furnaces for 180 pounds pressure = 15/32.

b. Water level should be approximately 3 feet above centerline. Top row of tubes should be approximately 70 percent of diameter of boiler above bottom of shell.

c. Depth of combustion chamber about 26 inches.

d. Tube area is dependent upon the length of boiler and the heating surface required. The number of tubes for this specific unit would be about 574 as a maximum.

Total area of cross-section of all stay tubes = 1,500 square inches (about 3/8 of total number of tubes should be stay tubes).

Tubes spaced vertically 4 inches between centers and horizontally 4 inches between centers.

Total heating surface, about 3,200 square feet.

Making Up With Salt Feed

Q. (962).—Why was blowing off and making up with salt feed admissible in marine practice years ago, while now it is inadmissible?

A. (962).—In the early days of marine engineering the pressure and temperature of the steam were low and the jet condenser the one in general use. The boiler feed was taken from the condenser, and, consequently, was practically the same in salinity as sea water. The density of the water in the boiler was kept down by frequent blowdowns, and usually was between 1.5/32ds and 2/32ds. However, the scale-forming salts, such as magnesium and calcium sulphates, are not thrown completely out of solution until the temperature of the solution is about 286 degrees F., which corresponds to a pressure of 39.3 pounds per square inch, gage. A small amount of scale was formed, nevertheless, before this temperature was reached.

As pressures were used above 39.3 pounds per square inch, the formation of scale was rapidly increased. Blowing off to reduce to the desired density at pressures above 40 pounds required such a large amount of extra feed, and consequently the formation immediately of considerable quantities of scale, because the scale-forming salts are all deposited. Due to this blowing off, a large amount of heat is also lost. It was found necessary because of the above reasons to abandon the use of salt feed and the jet condenser.

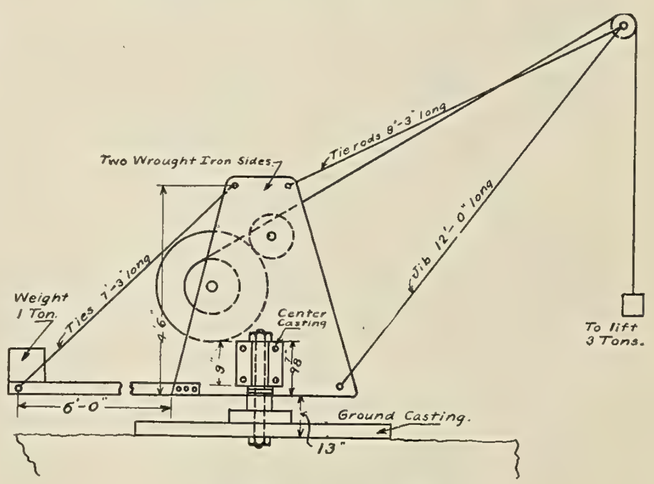
At present the feed water is made fresh by the use of an evaporating system and consequently the formation of scale is prevented. As it is difficult to keep condenser tubes packed perfectly tight, the cooling water, which is salt water, will pass into the boiler (the quantity depending, of course, upon the leaks). The scale formation, however, is inconsiderable and can be prevented by the proper use of soda ash.

Consequently, as the prevention of scale-forming salts passing to the boiler is accomplished by the use of distilled water, it should not be necessary to blow off very frequently.

Calculations for 3-Ton Revolving Hand Crane

Q. (956).—The sketch shows a small revolving hand crane. The center pin is tight in the center casting and revolves by a collar on balls in the ground casting. Please show how to find the bending moments and the diameter of the pin.

A. (956).—The data are not quite complete, as the distances of the points of attachment of the jib arms from the center line of the pin are not given; but, estimating



Sketch of Hand Crane

these and plotting the structure to scale, I get the perpendicular distance from the line of action of the load to the pin to be 8.08 feet, and from the counterweight to the pin 7.5 feet. Using these, the overturning moment due to the load is $3 \times 8.08 = 24.22$ foot-tons. The righting moment due to the counterweight is $1 \times 7.5 = 7.5$ foot-tons. Therefore, the net overturning moment is $24.24 - 7.5 = 16.74$ foot-tons.

This is the bending moment acting on the pin between the base casting and the upper body, tending to bend or

*Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

break it. The stress due to this bending is expressed by the formula $f = \frac{MY}{I}$. Where

f is the fiber stress.
M the bending moment.
Y the distance of the most strained fiber from the neutral axis of the section (equal to the radius of the pin in this case).
I is the moment of inertia of the section.

All expressed in units of inches or pounds.

Since the diameter of the pin is not known, we must assign an allowable fiber stress in order to permit solution for diameter. Taking 10,000 pounds per square inch as an allowable working stress, the formula becomes

$$10{,}000 = \frac{MY}{I},$$

and substituting the values of

$Y = \frac{\text{Diameter}}{2}$, and $I = 0.0491\ D^4$, we get $\frac{I}{Y} = \frac{1}{0.0982\ D^3}$,

and, substituting this value in our original equation,

$$D^3 = \frac{M}{982}.$$

Substituting the value of the bending moment obtained at first of 16.74 foot-tons.

$$\text{Diameter}^3 = \frac{16.74 \times 12 \times 2{,}240}{982} = 458 \text{ inches.}$$

$$\text{Diameter} = 7.68, \text{ or } 7\tfrac{5}{8} \text{ inches approximate.}$$

This does not take account of the direct compressive stress due to the total load of 4 tons, which should be added to the original stress of 10,000 pounds to obtain the final stress in compression (10,000 + 194 = 10,194 pounds, and subtracted to obtain the final stress in tension). (10,000 — 194 = 9,806 pounds.) It is, however, small in this case and may be neglected, but should always be figured. For allowable fiber stress of 12,000 and 15,000 pounds per square inch we would get 7¼ inches and 6¾, respectively, for the approximate diameters.

Parts of a Ship Requiring Calking

Q. (963).—I would like to know what parts of a ship are calked and what rivets are calked; also, where the felt packing is placed in regards to watertight and non-watertight parts, etc.?

A. (963).—A certain degree of watertightness is always obtained by spacing the rivets sufficiently close together. Since it is not always desirous to adopt a very close spacing of rivets, calking is resorted to. Briefly, those parts of a ship that are calked are the following: Scarfs of the bar keel, shell plating, tank top, floors where double bottom is divided into various compartments, bulkheads bounding bars, steel decks which are exposed to the weather, plating around watertight doors, bounding bars around watertight hatches and several other places of minor importance. The forward collision bulkhead is calked on the after side and the after collision bulkhead is calked on the forward side. In the case of decks uncovered by erections, watertightness against shell is secured by calking gunwale bar against shell and against deck. Angle clips connecting a non-watertight member to a watertight member should be calked all around its edge.

In general, where the plating is very thin, where watertightness is of importance, and especially where the joints are liable to great strains, as in the outer shell of torpedo boats, watertightness is obtained by the use of felt packing. Also used between doubling plates, since it is difficult, especially on the curved surface of the outer shell, to obtain a perfect fit between the plates. The use of soft packing as a substitute for calking should be confined to joints which cannot be readily or properly calked, as in watertight collar angles, tank divisions, margin plate lugs, bars on tank top, etc.

Rivets are calked only where watertightness is of particular importance or in oiltight work, and should in such case be countersunk on the point, although where necessary heads and points of rivets are calked.

Inclined Propeller Shaft

Q. (966).—Is a propeller shaft ever inclined upwards toward the stern of a ship, or is the shaft always parallel to the base line or inclined downward? What advantage, if any, is gained by inclining a shaft? I had a case the other day of having to change the stern frame casting to give more clearance between it and the propeller, and it occurred to me the shaft could be raised a few inches aft to avoid this change. I have never seen a shaft inclined up, so would like your opinion. Does inclining a shaft affect the thrust?

A. (966).—The centerline of the shaft may be parallel to the keel or inclined a slight amount either down or up as you proceed aft, the latter being the most common. The location of the centerline at the sternpost is usually determined by the diameter of the propeller, and for low revolution propellers is placed as low as the diameter will permit. The forward end is fixed by the bedplate and engine foundation, and it is usually preferable to keep the foundation low, even though the shaft incline upward slightly as we proceed aft. With turbines having large rotors the forward end may be slightly higher than the after end. The thrust is affected only as the cosine of the angle between the direction of motion of the ship and the axis of the shaft, and is inappreciable for angles up to 5 degrees (cosine 5 degrees = .996).

Highest Speed Attained by Hydroplanes

Q. (968).—We have had considerable discussion lately on a point which we hope you can settle for us. The question has been raised whether a water-supported boat, hydroplane, or other vehicle has been driven at a greater speed by means of a water propeller or by an air propeller. Undoubtedly, the greatest speed has been obtained with a contrivance embodying hydroplane principle. By hydroplane I mean a water plane without air supporting wings.

It is my remembrance that the highest speed obtained by an ordinary racing boat employing the hydroplane principle, and driven from water, is in the neighborhood of 75 miles per hour. Could you advise me definitely just what this record is and if it has been bettered by a hydroplane from the air? I believe there have been several such machines constructed without the body of a boat, which is customary with ordinary racers, and that these types will not stay on the surface unless in motion at or above a certain speed. Some of these have made very high speeds, and I hope you are in a position to advise me authentically just what is the highest speed obtained by this means?

A. (968).—The national one-mile motorboat championship race, Minneapolis, Minn., August 28, 1917, was won by *Miss Detroit II*, of the Detroit Power Boat Association, the only starter. Average speed for six one-mile dashes against time, 61.72 miles per hour. The *Whip-Po-Will*, a 28-foot hydroplane, owned by A. L. Judson, A. P. B. A., averaged 69.39 miles per hour in six one-mile time trials on Lake George, November 6, and covered one mile in 51.55 seconds, or at the rate of 70.15 miles per hour in its best dash. I believe air propeller driven gliders in France have gone to 90 miles an hour and higher, but have no definite recent figures.

Springs

Q. (969).—I am in need of a formula to get immediate practical results on springs and the relation between long and short beams and shafts to figure out their strengths? M. B.

A. (961).—The general discussion of springs is given in any good book on applied mechanics, or Kent's mechanical engineers' handbook, pages 417-424, or Mark's mechanical engineers' handbook, pages 425-432. If you will send on data for a specific problem I will be glad to indicate the solution and make the computation.

Shipbuilding and General Marine News

**Contracts for New Ships—Shipyard Improvements—
Engineering Projects—Improved Appliances—Personal Items**

182 STEEL SHIPS LAUNCHED SINCE BEGINNING OF CAMPAIGN

Eighty-five Requisitioned Vessels Finished and Turned Over to Shipping Board

A total of 182 steel vessels have been launched in American shipyards since the beginning of the shipbuilding campaign, according to a statement made public by the Shipping Board on April 2. Along with the statement of launchings the board gave out these additional facts:

REQUISITIONED SHIPS COMPLETED

Eighty-five requisitioned vessels have been finished and turned over to the Shipping Board.

Fifteen requisitioned ships have been reconveyed to their former owners before completion. These fifteen are now in service.

Three contract steel vessels have been completed and turned over to the Shipping Board and are now in service.

One hundred and seventy requisitioned vessels have been launched.

Twelve contract steel vessels have been launched, nine of them now being fitted out. The twelve includes the three completed and delivered contract vessels.

TONNAGE OF FINISHED VESSELS

The total tonnage of the 170 requisitioned ships launched is 1,173,217 tons. The tonnage of the twelve contract vessels is 99,200 tons. The three delivered contract vessels aggregate 26,400 tons, and the nine uncompleted contract ships 72,800.

All the steel contract launchings and all the wood ship launchings have been from yards which were built from the ground up. More favorable weather conditions have enabled the yards on the Pacific Coast to make more speed than those on the Atlantic.

Plan for the Mobilization of Lake Shipping Resources

When the Government took from the Great Lakes all vessels that were available for ocean traffic, the Lake Carriers' Association got together and decided to make up for the loss through a concerted effort toward getting a greater efficiency out of the remaining fleet.

Following that action, committees representing pig iron, iron ore, coal industries and railroads agreed that there should be the closest possible co-ordination and co-operation between these interests and the bulk freight vessels, and plans were formulated for an iron ore and coal exchange, under the supervision and direction of an executive committee of four, one member to represent each the iron ore, coal shippers, railroad and the ships.

This committee is to have power to regulate the assembling movement and distribution of bulk freight on the Great Lakes as will best serve the public interest, and in order to co-operate to the fullest extent possible in this movement it was considered necessary that the mobilization committee shall have full charge of the direction of the bulk freight vessels.

New York State Barge Canal Under Railroad Administration Control

Director-General McAdoo has taken over the Erie & New York State Barge Canal system for the Railroad Administration, and has ordered that a fleet of barges be constructed immediately under the direction of G. A. Tomlinson, Duluth, Minn.

These barges will be of the most approved type, and will be operated as a part of the general railroad and waterways transportation system of the country. It is planned to order several hundred barges immediately, to be built on the Great Lakes.

The cost of each barge will be in the neighborhood of $60,000.

SHIPYARD DRAFT EXCEEDED

Approximately 260,000 Men Enrolled in Public Service Reserve

Through its Public Service Reserve, the United States Employment service has registered approximately 260,000 mechanics to meet future needs of the shipyards or calls for men of special trades, the Department of Labor announces. This number exceeds the goal of a quarter of a million which was set at the start of the drive a month ago, and all States are continuing enrollments.

The Federal Employment Service states that this reserve will be drawn upon gradually, since large numbers of men are not in immediate demand by the yards, and the unemployed workers applying at branch offices of the Employment Service will first be used. As ship construction progresses, however, the reserve will be called upon to furnish men in increasing numbers.

Shipbuilders Send Ambulance to France

The 4,600 workmen of the James Shewan & Sons Dry Dock & Repair Yards, Brooklyn, N. Y., have presented the American Red Cross Society with a fully equipped ambulance, costing $5,000, ready to be shipped to France.

GOVERNMENT PLANT FOR BUILDING CONCRETE SHIPS PLANNED

$50,000,000 Appropriation Approved by the President

President Wilson has approved an estimate of appropriations for $50,000,000 for the acquisition or establishment of plants suitable for concrete shipbuilding, or "for the enlargement or extension of such plants as are now or may be hereafter acquired or established, and for the cost of construction, purchasing, requisitioning, or otherwise acquiring such concrete ships."

THREE LAUNCHING WAYS PLANNED

The Shipping Board had already planned to construct three launching ways for three 3,500-ton concrete vessels, and if these proved to be successful the board had then intended to go to the 7,500-ton type. But with this large appropriation in sight, Chairman Hurley said that rush work will be immediately begun at the projected plant in Wilmington, N. C.

New Shipyards and Extensions Planned

The Columbia River Shipbuilding Corporation, Portland, Ore., H. A. Killan, purchasing agent, is planning to install two additional ways, giving it an output of eighteen wooden vessels annually.

The Southwestern Shipbuilding Company has been organized in Los Angeles, Cal. Arthur C. Hurt, E. A. Mills, J. D. Flora and John C. Cain, Los Angeles, are the incorporators.

Charles B. Stanford, Charles H. Hamlin and others are organizing a shipbuilding company at Bangor, Me., to revive shipbuilding in the Statson yard at Brewer, Me.

The Maritime Engineering Corporation has been organized in New York City and has acquired a site on Goat Island, Elizabeth City, N, C. It plans the immediate construction of a yard to build steel vessels. Russell B. Smith, 50 East 42d St., New York, is president.

It is reported that the American Shipbuilding Company, E. W. Cook, 11 Broadway, New York, purchasing agent, will establish a yard at Quincy, Mass., for building wooden ships.

The Milton Shipbuilding Company has been organized at Yarmouth, N. S. Armand Deveaux is among those interested.

The Fraser Shipbuilding Company has been organized at New Westminster, B. C., to build wooden, steel and concrete ships.

The New York Shipbuilding Corporation, Camden, N. J., L. G. Buckwalter, purchasing agent, is building extensions

to its yard in order to double its present capacity.

Doullut & Williams, New Orleans, La., are planning to build a shipyard on the proposed municipal industrial canal.

The Carolina Shipbuilding Company has been organized at Charleston, S. C., and is represented by Philip H. Gadsden.

The Gulf Shipbuilding Company has been incorporated at Pascagoula, Miss., by A. F. Dantzler, H. H. Colle and B. G. Boag.

It is reported that the National Shipbuilding Company, Orange, Tex., is planning to build a shipyard at New Orleans.

The Concrete Ship & Barge Corporation, recently organized in New York City, is planning a shipyard at Biloxi, Miss.

The Tampa Dock Company, Tampa, Fla., J. L. McGucken, purchasing agent, is planning extensive additions to its yard.

NEW YARD AT ALEXANDRIA

Fred T. Ley & Company, Inc., Springfield, Mass., have received the contract for building the American Shipbuilding Company's yard at Alexandria, Va. The purchasing agent of the American Shipbuilding Company is E. W. Cook, 11 Broadway, New York. It is reported that the company has received contracts to build twelve steel steamships for the United States Shipping Board.

The Inter-Ocean Barge & Transport Company has been organized in Seattle, Wash., where it is the intention of the company to build concrete ships. It is reported that the company has already received a contract from the United States Shipping Board to build several concrete ships.

The Macrenaris Shipbuilding Company has been organized at Tarpon Springs, Fla., to build coasting steamers. E. Macrenaris is manager.

The American Shipbuilding Company, Brunswick, Ga., purcahsing agent, E. W. Cook, 11 Broadway, New York, has increased its capital stock from $50,000 to $5,000,000 and is reported to be planning extensive additions to provide for new Government contracts for steel steamships.

TO BUILD CONCRETE SHIPS

The Fougner Steelconcrete Shipbuilding Company, N. K. Fougner, president, 18 East 41st St., New York, main office, Christiania, Norway, is planning to build a yard for the construction of steel-concrete steamships.

The Newcomb Life Boat Company, Newport News, Va., will build a marine railway of the Crandall type, with a capacity of 5,000 tons.

The Inter-Ocean Barge & Transport Company has been organized at Seattle, Wash., and is planning the erection of a plant for the construction of concrete ships.

The Florence Shipbuilding Company has been incorporated, with headquarters at Eugene, Ore., and will build wooden ships.

The Federal Shipbuilding Company, Robert McGregor, general manager, a subsidiary of the United States Steel Corporation, 71 Broadway, New York, has purchased 93 acres adjoining its plant at Kearny, N. J., with the intention of making large additions.

The Murnan Shipbuilding Corporation, H. C. Murnan, general manager, Mobile, Ala., has purchased a tract on the east shore of the Mobile River and is planning extensive additions to its yard, where steel ships will be built.

The United States Shipping Board has selected Charleston, S. C., as the site of the two aditional shipyards to be constructed on the South Atlantic coast.

The Shell Banks Shipbuilding Company, Mobile, Ala., Varian C. Scott, president, John Jones, vice-president, Ernest F. Ladd, treasurer, Edwin Scott, secretary, succeeds the Scott Shipbuilding Company. The company is planning to build schooners and other wooden ships.

The Barnes & Tibbitts Shipbuilding & Dry Dock Company, Alameda, Cal., has been organized with the intention of building ships for the United States Government.

O. A. Johansen, president of the Western Shipbuilding Company, Oakland, Cal., which will specialize on wooden vessels, states that the company has already received contracts totaling more than $4,000,000.

The American Shipbuilding & Transportation Company, Boston, Mass., is planning the construction of a shipyard at Quincy, Mass., with five launching ways for wooden and concrete ships.

The Darien Shipbuilding Company has been organized in Darien, Ga., to construct wooden ships. The officers are: Robert Manson, president; F. H. McFarland, vice-president; R. J. Downey, secretary and treasurer, and T. S. Lawrence, general manager.

Norway Loses 745 Ships Valued at $330,000,000

Norway's shipping losses through German submarine ruthlessness and other war operations continue to grow. During March nineteen ships of 34,994 tons were lost. The total value of Norway's shipping losses for March in round figures is almost $10,500,000.

With the March sinkings Norway's losses since the beginning of the war amount to 745 vessels, with an aggregate tonnage of 1,101,815, valued at $330,000,000. In addition, fifty-three vessels are missing, two-thirds of which are set down as war losses.

Norwegian seamen to the number of 986 have lost their lives in the sinkings, while on the fifty-three missing vessels there were 700 men.

How the French Settle Ship Labor Disputes

Publicity is the sole means employed by the French Government in enforcing decisions in the case of disputes between seamen and employees in the merchant marine.

According to advices just received by the Bureau of Labor Statistics of the Department of Labor, the port wardens of the various ports are required to offer their services as conciliators in all disputes involving twenty or more men. In case of failure of such arbitration the matter is referred to a superior committee of 12, made up of equal numbers representing employers and employees. Two members must be magistrates when the board is ready to decide a case; its decisions are announced by means of posters displayed at the entrances to the offices of the port. No penalties for non-compliance are provided for.

SPECIAL TRAINS TO BRING LUMBER FROM PACIFIC STATES

Atlantic Coast Shipyards to Be Supplied in One-Fifth Ordinary Time

Special trains bringing huge fir logs from the Pacific lumber States will speed up wooden ship construction this month along the Atlantic and Gulf coasts. An arrangement, entered into by Chairman Hurley, of the Shipping Board, and Director General McAdoo, of the Railways, will rush 50,000,000 feet of Douglas fir across the country in one-fifth of the time usually required for the journey.

Eighteen wooden ships, totaling 63,000 tons, are to leave their ways before May 1. The transportational preference will expedite about half of this total into the water. Upwards of 20,000 additional tons of wooden ships are also due to be launched this month under private contracts.

SUPPLY OF YELLOW PINE

The rush shipments of heavy firs are an emergency measure put in effect to bring the Atlantic and Gulf plants up to the programme set for them some time ago by Chairman Hurley. Special surveys of the pine regions of the South, now virtually completed, promise in another month to supply from that part of the country all the heavy yellow pine that will be required by the Gulf and Atlantic yards. Changes in specifications for wood ships hereafter to be built in the South and East will make the Southern pine thoroughly satisfactory. These ships will average about 4,000 tons.

Of the 18 ships in sight May 1, barring unavoidable setbacks, the schedule made public by Chairman Hurley shows the output of the East and South breaking about even for the first time with the West. Nearly all the Eastern and Southern yards making this achievement date back only to last year in their organization and equipment. Wood shipbuilding was practically obsolete along the Atlantic and Gulf when they got under way, and they were obliged to learn the game from the ground up. Nearly 75 percent of their workmen were formerly house carpenters.

INDICATE RECORDS WILL BE BROKEN

All reports from these plants to Chairman Hurley indicate record-breaking production for the remainder of the year. The established Pacific Coast yards having readily accessible lumber report their progress up to schedule, with every likelihood of attaining greater rapidity.

A compilation prepared by the statistical department of the Shipping Board shows the amount of work which Oregon has been doing and expects to do in the way of shipbuilding. Up to date 127 vessels have been built, contracted for and requisitioned in that State.

United States Gets Japanese Ships in Exchange for Steel

Arrangements have now been made, as a result of the negotiations between the United States and Japanese shipbuilders, for the purchase of twelve Japanese

ships of approximately 100,000 tons deadweight capacity, which will be added to the fleet of the United States Shipping Board within the next few months. All of the vessels are large, modern steamers of 6,000 tons or over, with one exception, and none over two years old. Some, indeed, are still awaiting completion. Deliveries of the ships at American ports are to begin not later than May and to be finished in September, a progressively higher price per ton to be paid according to the month of delivery as a premium on early deliveries.

Steel for Japanese Builders

In return for the sale of the ships the War Trade Board has agreed to deliver to the Japanese shipbuilders a corresponding amount of steel for shipbuilding ton for ton against delivery of the ships.

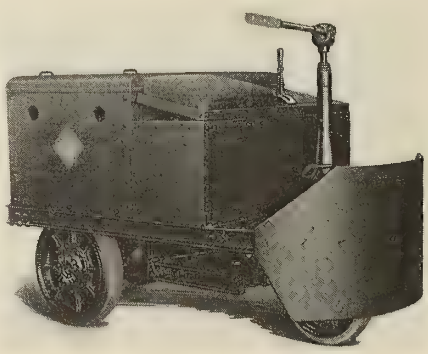
Further negotiations are in progress to secure from Japanese shipbuilders 200,000 additional tons of new construction, the ships to be built in return for new steel placed at the disposal of the builders by the War Trade Board.

Arrangement of Hoisting Crane on Elwell-Parker Truck

Triple Utility Industrial Truck

In order to extend crane services beyond the reach of present travelers to more remote parts of the storage yard the crane-equipped electric industrial truck, as manufactured by the Elwell-Parker Electric Company, of Cleveland, is found useful. It consists of a substantial crane carried on a ball bearing pedestal, the boom of which may be swung to right or left 28 inches over the side of the truck. The lifting capacity is 1,000 pounds at maximum outreach.

The hoisting mechanism consists of a totally enclosed reduction and hoist drum with special Elwell-Parker low-voltage reversing motor directly attached. This motor receives power from the same battery that furnishes current to the separate propelling motor. The hoist controller is located at the rear of the motor next to the operator.

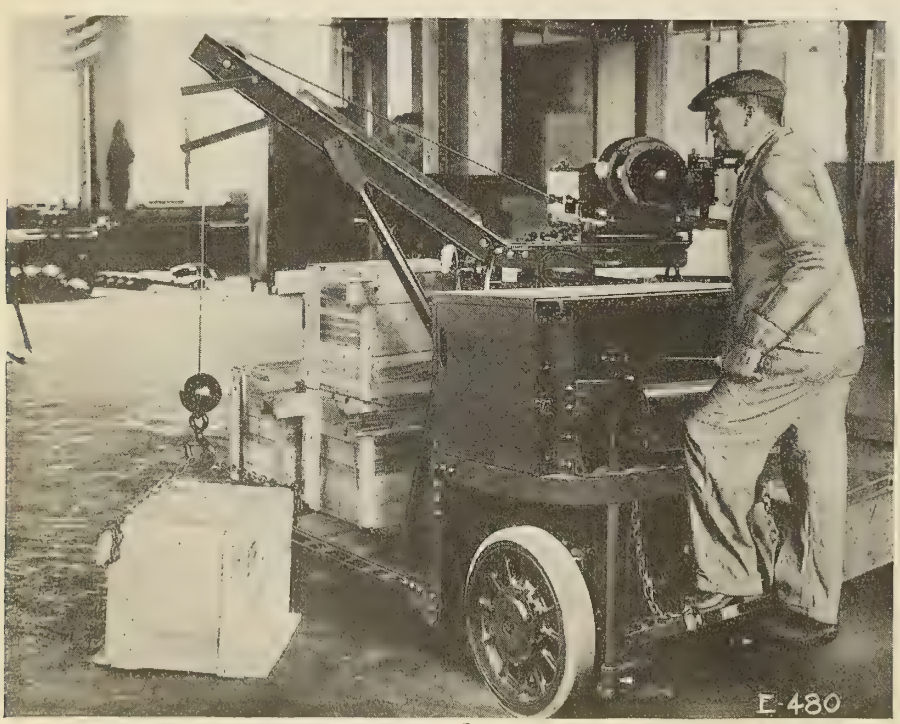


Three-Wheel Elwell-Parker Tractor

The hoisting unit is mounted on and revolves with the crane boom, counterbalancing the load to some degree. A special trip switch opens the motor circuit when the hook reaches a certain predetermined height. A ball weight facilitates lowering the hook when empty.

This crane is mounted on a standard four-wheel-steer, single-reduction, direct-connected, worm-driven truck, with large-size drive wheels 21½ inches by 3½ inches and 15 inches by 3½ inches trailing wheels, which give a platform height of 17 inches. Ample clearances are thus provided throughout the length of the truck. The loading platform is 92 inches by 40 inches and provides ample space for a 4,000-pound load, which is the capacity.

The handling of pieces of more than two hundred pounds usually requires more than man power. The suitability of a revolving power crane on a power truck to perform this work is unquestioned. It may be used to take boxes, castings or barrels from a warehouse or car floor, load them directly onto its own carrying platform or swing the pieces through an arc of 180 degrees and deposit them on a trailer waiting on the opposite side. If desired, the crane truck may be used as a tractor to draw the string of trailers it previously loaded. It, therefore, becomes a triple-utility self-loader, carrier or light tractor—a most valuable general utility tool for any warehouse or shipyard. Two men with this will do the work of ten, it is claimed.



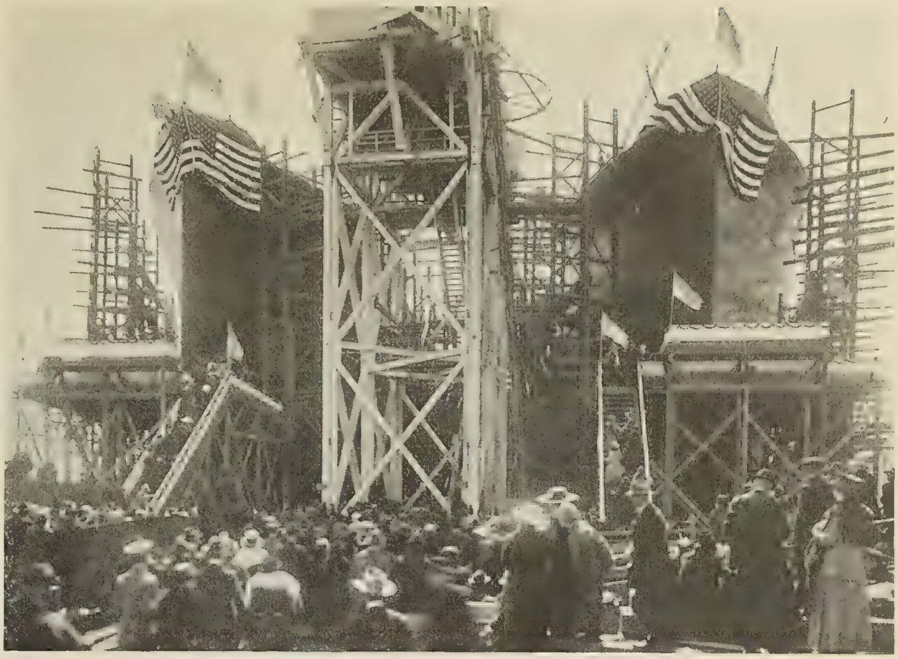
Hoisting Mechanism on Elwell-Parker Industrial Truck

Since traction or adhesion depends wholly upon the weight and the ability of the motor to revolve the wheels under that weight, so long as the current supply holds out any electric industrial carrying truck may be used as a light tractor. Elwell-Parker trucks and tractors are equipped with motors which will take care of all the power in the battery as fast as determined by traction. A heavy duty type four-wheel-steer tractor has been found especially suitable for most freight terminal work. The more important war terminals are being equipped with that type.

To meet a certain demand for a tractor to fit in between the carrier truck and heavy duty tractor, a three wheeled tractor has been designed and is giving excellent service in small package freight houses. Its battery capacity and weight over drivers is midway between that of the truck and tractor. It is a three wheeler, and instead of turning all four wheels the front turns at an angle equivalent to the sum of that on the front and rear of a heavy duty tractor.

The tractor is built for medium service, occupying a position about halfway between an ordinary electric truck and a heavy duty tractor. One of the most distinctive features of this tractor is that it has a single front wheel. It is steered by a hand wheel or a hinged right and left lever. When the wheel steer is used the control lever is located on the left of the column. When the lever steer is used a control lever is provided at the side of the operator's seat, as shown. The steering wheel is carried on roller bearings in a heavy steel fork, spring supported, turning on large ball bearings in the steering column base. The seat operates as a circuit breaker, which closes when the operator's weight presses the spring, but only when the controller is in off position. It cannot be started from the floor.

The tractor has solid wheels and solid rubber tires. The normal drawbar pull is 300 pounds and 850 pounds maximum. The speed with no load is 625 feet per minute. Its length is 70 inches and width 41 inches. The outside turning radius is less than the length of the tractor.



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Twin Launching of S. S. *Shintaka* and S. S. *Aniwa* at Oakland, Cal.

A New Tool That Fills a Long-Felt Want

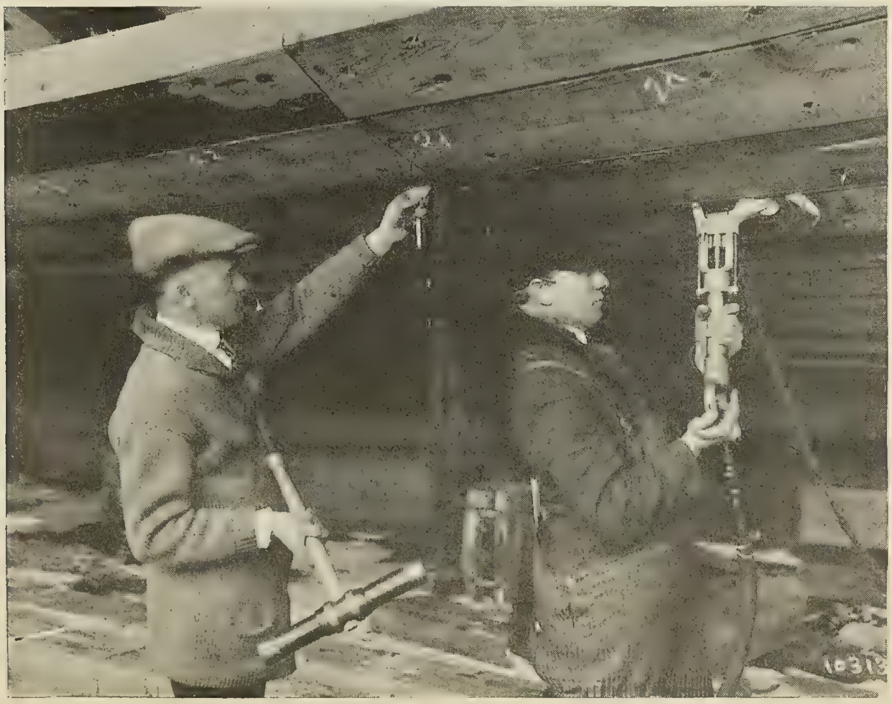
Shipbuilders will be interested to learn of the perfection of a practical pneumatic calking machine. This tool, known as the "Little David" calking machine, is being placed on the market by the Ingersoll-Rand Company, 11 Broadway, New York, who report an enthusiastic reception wherever it has been introduced.

The pneumatic calking machine weighs but $13\frac{1}{2}$ pounds, and observed performances show that it can be easily handled and operated in any position. It automatically tacks either machine or hand-spun oakum in side or bottom seams to any depth required for final horsing. On deck planking it will do the horsing. Its working speed is about 1,500 tacks per minute, either coiling or running the oakum straight.

The "Little David" calking machine is controlled by a trigger similar to a light scaling hammer. It differs, however, from the usual hammer in that the piston has an extended rod fitted with a thin calking blade. This, being a reciprocating iron with positive pull back, has no tendency to bind. The calking iron travels in guides, which prevent it from turning, the whole being fitted with springs, so that the workman can vary the penetration of the calking iron with the varying depth of the seam. A unique device automatically feeds the oakum with each movement of the calking blade. Guide wheels run in the seam being calked and keep the threading iron lined up. The tool operates with negligible vibration, and its design is such that it follows without effort on the part of the workman; in fact, machine calking is so simple that ordinary workmen can do highly efficient work.

A demonstration was recently conducted before the United States Shipping Board Emergency Fleet Corporation and the tool was approved by them. The tool measures 22 inches in overall length. The ordinary equipment consists of a calking iron of 1/16-inch thickness, although ⅛-inch iron can be furnished if desired.

This tool should immeasurably increase the speed of wooden shipbuilding, which up to now has been hindered by an inadequate supply of calkers. Any device which will speed up shipbuilding, or, for that matter, any war industry, should be accorded wholehearted support. They place the country and our Allies that much nearer the winning goal.



The Old and New Ways of Calking a Wooden Ship

Dallett Boiler Shell Drill

A motor-driven boiler shell drill, designed to use high-speed steel drills, is manufactured by Thos. H. Dallett Company, Philadelphia, Pa.

This machine consists of two or more drilling heads and two horizontal bars of whatever length may be specified, the lower one being provided with a rack on the under side. This outfit may be incorporated on a housing of the purchaser's own design, in which provision can be made for raising or lowering by

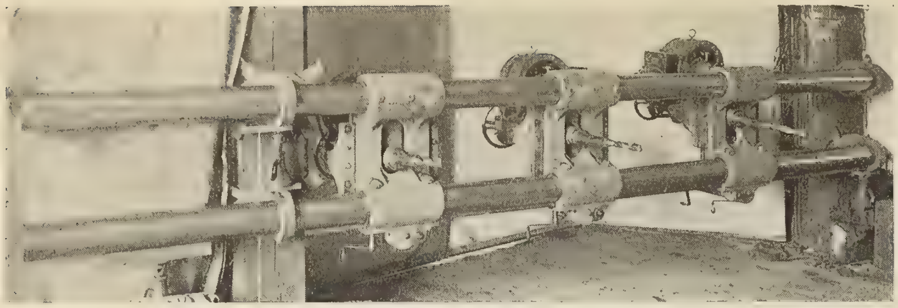


Fig. 1.—Front View of Dallett Boiler Shell Drill

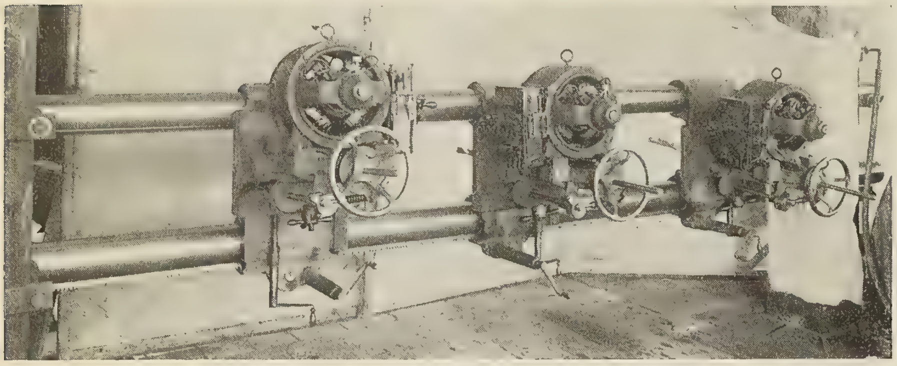


Fig. 2.—Back View, Showing Motors and Control

means of screws connected together at the top by a horizontal shaft and bevel gears, or it may be attached to the structural elements of a building by use of yokes to hold the bars the proper distance apart. The columns of the building may be provided with a series of holes, so that when a shell of a different diameter is being drilled, the whole device can be raised or lowered to the proper place and bolted fast. This latter method answers all purposes in the majority of cases, as the range of the machine within itself is such as to make

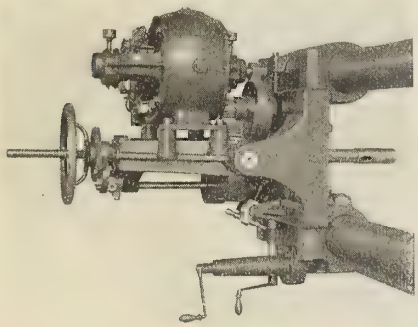


Fig. 3.—Side View

unnecessary the continual raising or lowering of same in actual operation, especially if a number of boilers of the same size are being drilled.

The shell is placed in front of the machine on rollers, and, as each head has a vertical movement and the spindle can be tilted, a hole can always be drilled radially to the center of the boiler. Each drilling head has a vertical adjustment in itself of 6 inches, operated by a crank handle at the bottom, and is moved along the bars by means of a pinion and rack on the under side of the lower bar. The spindle is 2 1/16 inches in diameter and bored for a No. 4 Morse taper. It has a traverse of 16 inches and a range through an arc of 15 degrees, to permit drilling radially, as before mentioned, the latter movement being controlled by the hand wheel, which appears immediately beneath the gear reduction in Fig. 3. The motor pinion and gearing are arranged to give the proper spindle speeds to suit the work in each individual case. There are no bevel gears used in the transmission from the motor shaft to the spindle, spur gears only being used, making a very durable and efficient gear reduction.

The feeding mechanism consists of a feed shaft, crank head, rocker pawl, ratchet wheel, feed nut and feed screw, the thrust of the latter being directly upon the back end of the spindle. The connecting rod between the crank and rocker plate is fitted with a spring, which can be set for any pressure of feed, so that it is impossible for this pressure to be exceeded, as the spring is compressed when the limit is reached and the feed ceases to operate until the pressure is reduced, thus making an automatic relief. Change of feed is effected by shifting the thumb latch around the crank head, and a range of feeds from .005 per revolution of spindle to 1/16 inch can be obtained. This range of feeds covers the entire requirements of drilling in boiler work.

An especially noteworthy feature of the machine is the central position of the spindle not only between the bearing of the drilling heads on the bars, but also between the bars, so that the pressure of the drill head against the work has no tendency to set up torsional or sidewise strains in the drill head or bearings, causing excessive friction of the drill in the hole, rapid deterioration of the drill and undue consumption of power, owing to the spindle being thrown out of alinement, as is the case where a drill spindle is not central of its support.

Each drilling head has individual motor drive, and the machine is entirely self-contained, all adjustments being effected by means of crank handles and hand wheels, no wrenches whatever being required, and the operator has all the adjustments of the head at his command from either side of said head without moving from his position.

The Spray Method of Applying Paint Proves Useful in Shipbuilding

The modern method of applying paint and other surface coatings is by the use of compressed air. This is rapidly superseding the old hand-brush methods, not only by reason of the great saving in time and labor, but also due to the fact that better results are obtained.

The photograph (page 319) shows a painting equipment supplied by the Spray Engineering Company, Boston, Mass., which is compact, portable, and adapted for either shop or field use. It is ready for immediate use, with the exception of attaching the air hose and connecting to the compressed air supply. All the necessary adjustments are quickly made by hand, without the use of tools. Where compressed air is not available, gasoline engine or motor-driven air compressor units are installed.

It is claimed that with this device one unskilled man can do the work of three to twelve skilled painters using hand-brushes, depending upon the nature of the work. Finely finished surfaces, free from streaks and brush marks, are produced, and rough surfaces and those extremely difficult or impossible to reach with a hand-brush are easily and rapidly covered.

It is stated that the gun may be blown free of paint and cleaned without taking apart, and the paint gun may be quickly attached to an extension pole 8 feet 6 inches long, weighing, with the hose, 7½ pounds, for painting surfaces beyond the reach of the operator. By means of interchangeable nose pieces the standard gun is capable of handling all kinds of liquid coatings.

Concrete Ship Launched in Norway

A 600-ton motor-driven concrete boat was launched on March 11 at Moss, Norway. The boat was built by the Fougner Staal-beton Skibsbygnings-Compani at its shipbuilding yards at Moss. It is the first one of its type, special permission having been given for its construction as an experimental boat by the Norwegian Department of Commerce in 1917.

The boat's dimensions are as follows: Length, 145 feet; width, 27 feet 6 inches, and height, 15 feet 9 inches. It is said to have a displacement of 600 tons, and contains four watertight compartments and has a flush deck, slightly raised, the machinery being in the stern. There are two cargo holds with two hatchways, a crane with a 2-ton motor winch having been placed at each hatchway. The windlass, which has been put at the stern, can be operated by hand or by means of chains connected with one of the winches. The machinery consists of one 320-horsepower Bolinder motor, designed to run at 325 revolutions per minute.

INCREASED PAY FOR SHIPYARD WORKERS

Uniform Wage Scale for Atlantic and Gulf Coasts

Decision of Labor Adjustment Board

The Shipbuilding Labor Adjustment Board has handed down its decision in reference to wages, hours of labor and other conditions in the shipyards under its jurisdiction on the North Atlantic coast and Hudson River.

The wage scale announced is the same as that in the Chesapeake and Delaware districts and is an increase over present rates. A uniform wage scale will be put into operation for the entire North Atlantic and Gulf coasts.

Wage Scale

The wage scale prescribed for journeymen, helpers and laborers included the following rates:

Hammer and machine forgers, heavy, $1.35.

Anglesmiths and blacksmiths, heavy fires, 87½ cents.

Leading men, erecting department, gang leaders, mold loft, 85 cents.

Furnace men on shapes and plates (ship work), loftsmen, first class, 82½ cents.

Operators locomotive cranes in construction work, 82 cents.

Rivet testers, 80 cents.

Flange turners, slab furnace men, patternmakers, marine leaders, crane leaders, 75 cents.

Anglesmiths and blacksmiths other fires, boltmakers, coppersmiths, marine erectors and machinists first class, fitters first class, molders, cupola tenders, loftsmen second class, plumbers and pipefitters, bitumastic painters, 72½ cents.

Levermen or cranemen, blacksmith shop; drop forgers, boiler makers, tank testers, chippers and calkers, electricians first class, joiners, machine men, joiner department; operators, locomotive, cantilever, gantry and other cranes of over three tons; rivet testers, riveters, ship carpenters first class, wood calkers, layers out, sheet metal workers, metal polishers, buffers and platers bending rollers, 70 cents.

Leaders, furnace department; crane gang leaders, 67½ cents.

Welders

Acetylene burners and welders first class, electric welders, electricians second class, fitters second class, machine men, lumber department, engineers, locomotive, operators stiff legged derricks, ship carpenters second class, 65 cents.

Marine erectors and machinists second class, marine riggers, pressmen first class, 62½ cents.

Drillers, burners second class, regulators first class, painters and polishers, cranemen, erector leaders, 60 cents.

Stage builders, mangle rollers, 57½ cents.

Anglesmith helpers, heavy fires; heaters; blacksmith's hammer runner, heavy; blacksmith's helpers, heavy fires; liner forgers, planer hands; leader cleaning department; wiremen; firemen and helpers, furnace department; strikers, furnace department; wood reamers, punchers, planers and scarfers, countersinkers, pressmen second class, offsetters, fasteners, erectors (wood), 55 cents.

Linermen, 54 cents.

Fifty Cents for Erectors

Regulators second class, 52½ cents.

Specialists or handy men (machine shop), 52 cents.

Grinders, chippers, cranemen's helpers, drop forgers' helpers, holders on, bolters, cementers, packers, reamers, hand and machine chippers, locomotive conductors, road crane conductors, hoisting and portable firemen, erectors, 50 cents.

Sawyers, 47½ cents.

Burners' and welders' helpers, anglesmiths' helpers, other fires, blacksmiths' helpers, other fires, bolt makers' helpers, liner forgers' helpers, boiler shop helpers, coppersmiths' helpers, electrical department helpers, erectors' helpers, fitting up department helpers, foundry helpers, machinists' helpers, riveters' helpers, ship shed helpers, sheet metal workers' helpers, 46 cents.

Bolters' and liners' helpers, cementers' helpers, lumber helpers, mold loft helpers, painters' helpers, 42½ cents.

Laborers, rivet heaters, boiler shop, 40 cents.

Heater boys, 38 cents.

Passer boys, 30 cents.

Layers out to receive 3 cents per hour more than first class journeymen of same department.

Oakum spinners, $2.25 a bale.

Hours of Labor Prescribed

The decision prescribes in addition to the rates of pay, hours of labor and working conditions in detail. A maximum of twelve hours is fixed arbitrarily as a day's work, to discourage excessive overtime on the ground that such overtime would lessen efficiency of workers and slow up production. In addition, the two and three shift plan will be encouraged.

Plan Periodic Adjustment of Shipbuilders' Wages

Wages will be made to keep pace with the high cost of living if the purpose of a series of conferences between representatives of the Department of Labor and the Shipping Board is realized. If satisfactory figures showing the exact advances in living cost in shipbuilding centers can be worked out, it is hoped that an arrangement can be made by which adjustments of wages will be made periodically.

Wages Outdistanced by Food Prices

Commenting upon the plan, Assistant Secretary of Labor Louis F. Post said: "Wages and food prices have been racing each other and food prices have outdistanced wages. For every two-dollar advance in wages there is a corresponding three dollars or more in the cost of living. Unless these two things can be equalized the wage-earner is going to get smaller and smaller real wages no matter how much money wages he gets. The cost of living has been advancing at least 2 percent a month, and the man who is getting the same money wages that he did a year ago is only three-fourths as well off. Unless the wage-earner can have his pay envelope stabilized in terms of what it will buy rather than in terms of money he is bound to be the loser."

Summary of What Has Been Done Since the War Began By the Shipping Board and Emergency Fleet Corporation

The following statement concerning the activities of the United States Shipping Board and the Emergency Fleet Corporation has been prepared from data furnished the Committee on Public Information by officials of the administrations named. It covers briefly the operations of these organizations since the beginning of the war.

Big Problem at Outset

At the outset of the war the nation, in addition to expanding the army to proportions adequate to wage the struggle, was confronted with the problem of providing facilities to transport its expeditionary forces and the supplies necessary to subsist them in foreign fields.

One step designed to effect this purpose had already been taken; two others followed shortly after the declaration of war. Through the shipping act, approved September 7, 1916, Congress created a United States Shipping Board to encourage and develop a naval auxiliary, a naval reserve and merchant marine; empowered that board to form a corporation to purchase, construct and operate merchant vessels, which it exercised through the incorporation of the Emergency Fleet Corporation; and authorized a $50,000,000 fund for the operation of the corporation.

Authorized by Congress

By joint resolution of the Senate and House of Representatives approved May 12, 1917, the President was authorized to take over the German vessels within the jurisdiction of the United States, its territories and insular possessions, and under the emergency shipping fund provision of the urgent deficiency appropriation act approved June 30, 1917, the President was authorized to requisition any vessels under construction or contracted for in shipyards within the United States.

By Executive orders dated June 30 and July 3, 1917, the President ordered the Shipping Board to seize the German vessels in United States waters, and by another, of July 11, 1917, delegated to the board the power of requisition which Congress had vested in him.

To perform the tasks assigned to the Shipping Board and its operating company, the Emergency Fleet Corporation, large expenditures were necessary. Congress has met the demands by supplementing the original appropriation of $50,000,000 with succeeding authorizations, which on March 1 last aggregated $2,034,000,000, to be expended for construction, requisitioning and purchasing of ships, the construction of yards and the erection of housing facilities. Of the sum authorized, $1,135,000,000 had been appropriated on March 1. The expenditures of the Emergency Fleet Corporation up to that date totaled $353,247,955.37, distributed as follows: Wood ships, $74,590,519.22; steel ships, $77,968,172.89; steel ships requisitioned, $169,971,860.55; plants, $30,717,402.71.

Seizure of Enemy Ships

Under its power of seizure the Shipping Board has taken over 112 German

and Austrian ships of 788,000 deadweight tonnage, all of which have been repaired and are now in operation.

The building programme of the Emergency Fleet Corporation is divided into steel and wood construction. Exercising its power of requisition the Shipping Board on March 1 last had taken over 425 steel vessels of 2,998,108 deadweight tons, and had let contracts for 720 steel vessels of 5,166,400 deadweight tons, making a total of 1,145 steel ships, with an aggregate deadweight tonnage of 8,164,508 tons. Of the requisitioned vessels, 72, of 485,576 deadweight tons, had been completed and put into operation; 15, of 152,290 deadweight tons, had been reconveyed to their original owners before completion, while 52 of the 338 still under construction had been launched but not completed.

Of the contract vessels, 2, of 17,600 deadweight tons, had been completed on March 1. Three others, of 26,400 tons, have been launched.

The Division of Wood Ship Construction on March 1 had let contracts for 490 wooden vessels, aggregating approximately 1,715,000 deadweight tons. None of this number has yet been completed, but 17 had been launched on March 30.

The building programme of the Emergency Fleet Corporation was being carried on March 5 in 151 plants, 85 of which were engaged on wood construction and 66 on steel. Of the 151 plants, 81 are classified by the corporation as new, having been constructed especially to take care of contracts let by the Emergency Fleet Corporation, or just as this country was entering upon the war; the remaining 70 are classified as old plants, though some of them were erected to accommodate the boom in shipbuilding that developed in the United States in the early days of the European War.

At the time the Emergency Fleet Corporation was organized practically all the ways of the yards then in existence were occupied by vessels building for the Navy Department or for private contract. This condition of affairs necessitated the construction of the 81 new yards before the building of ships for the Emergency Fleet Corporation could be commenced.

To spur the shipbuilding industry to speed up the Government work, the Emergency Fleet Corporation has extended varying degrees of financial assistance to 63 plants, the aid going to the construction of shipways, plants and the installation of plant equipment.

Supplying Ship Workers

The expanded old yards and those newly constructed had to be manned. A pressing need for skilled workmen developed. To meet the situation the Emergency Fleet Corporation organized a nation-wide campaign and established training schools for the men recruited into its service. The results achieved can be best realized by comparative figures. Census reports for 1916 show that in 45 steel yards then reporting there were only 43,582 workmen employed, while reports made to the Emergency Fleet Corporation on February 16, 1918, by 53 out of a possible 63 steel yards, give an enrollment of 162,880. The census report for 1916 from 18 wooden yards record 1,380 workmen; those of the Emergency Fleet Corporation as of February 16 last, from 59 out of a possible 75 yards, record 29,959.

The Interesting Development of "John Crane" Flexible Metallic Packing

Seldom has an engineering invention or discovery attracted so much attention and created so much interest among operating engineers as has the now well-known "John Crane" flexible metallic packing. Since this packing is now firmly established, and since the history of successful products always furnishes inspiring reading matter, it is believed that the development of this packing will stimulate other engineers to greater effort for constant betterment of power plant conditions.

"John Crane" packing was invented by an operating engineer named John Crane in the early spring of 1912. John Crane then had charge of a large power plant and was directly responsible for maintenance and repair costs.

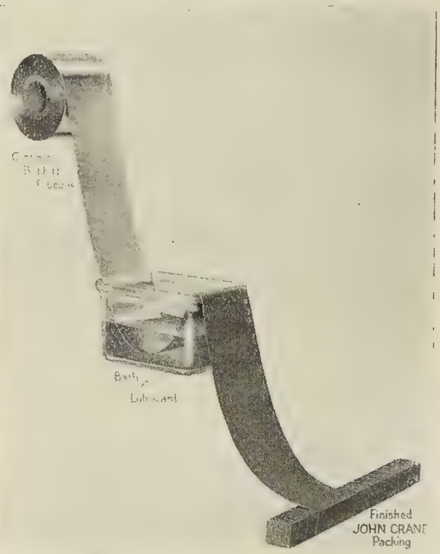


Fig. 1

John Crane's first object was to develop a permanent packing. From actual experience with his outside-packed plunger feed pump he knew that soft packings ordinarily lasted only from four to five months, depending upon the conditions of his plungers. Of course, he desired to reduce the bills to the very minimum and, if possible, to make his packing permanent. He noticed that where metal and fabric were combined in packings, such as metal studs or metal segments, the life of such packing was lengthened. He noticed also that these metals were not affected by heat or water, while the soft packings were. And not only did he notice that the metal lengthened the life of the packings, but it seemed to polish the plunger, and hence the idea came to him of an all-metallic packing.

Flexibility and compressibility were also desirable, necessitating some mechanical combination. Of course, it was possible to take metal and shred it and twist it in the form of rope, or braid it in the form of packing. This would give the flexibility. But would it be a packing through which pressure could not pierce? Being a pioneer, he had to settle many questions with himself. So, after much thought and experimentation, John Crane evolved the idea of taking long, thin, continuous strips of metal foil and wrapping it spirally round and round, back and forth, impregnating each sheet with a layer of lubricant to permit the sheets to slide on each other and to allow bending about the smallest diameter and giving it a compressibility sufficient to compensate for wear and sufficient to control any ordinary pressure. These

Fig. 2

spirally wrapped sheets, he found, formed perfect barriers through which pressure could not pierce and formed a strong, durable construction.

The idea of simplicity did not get away from John Crane. He had packed many stuffing boxes in his day and knew that a packing, which would be a success, must be simple to install; one that could be installed in the same stuffing boxes as soft packings and with equal ease. He, therefore, used soft metal, which could be cut with a knife, took any form or shape under pressure of the gland and bent about the plunger very easily. These features, he knew, would appeal to every experienced engineer.

Thus was John Crane's ambition realized. His analysis was correct. He was successful largely because he himself was an operating engineer and knew exactly what was needed.

"John Crane" products are now made up by the Crane Packing Company, 29 South Clinton street, Chicago, in all kinds of forms, die pressed, hand pressed, straight lengths, rings, coil form, spiralled from 1/32 inch thick to 2 inches, suitable for steam, air, ammonia,

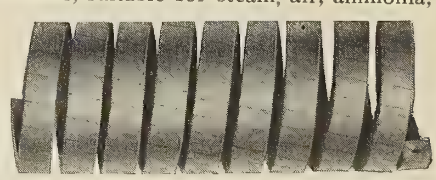
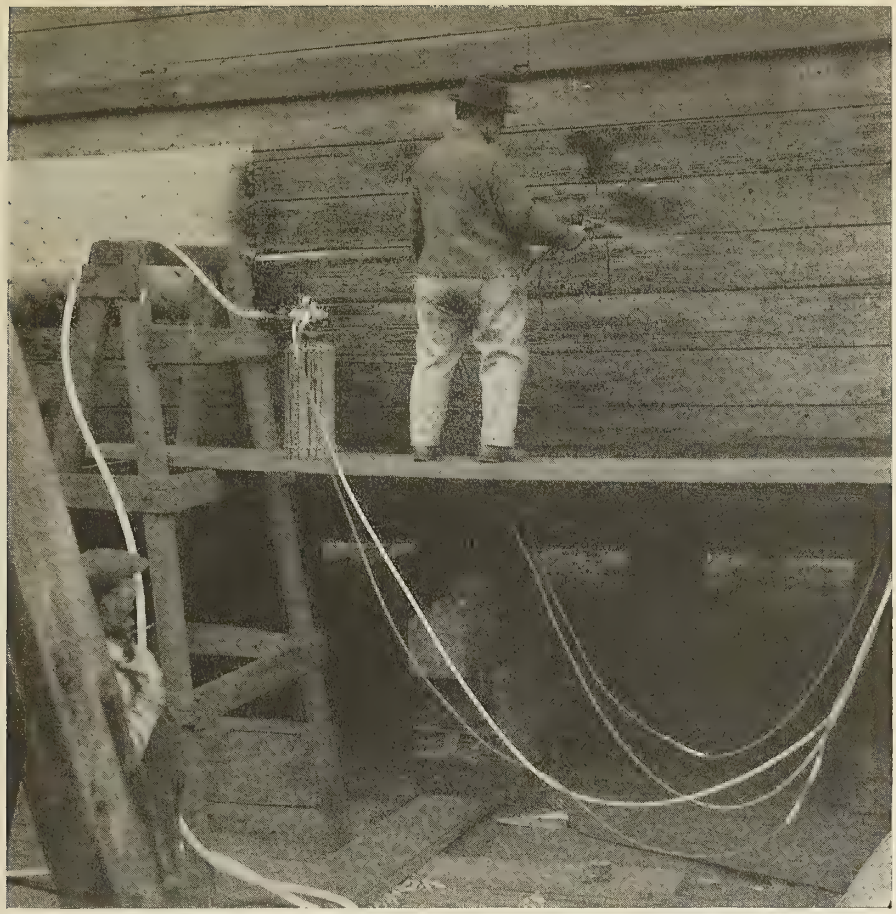


Fig. 3

hot or cold water, high or low pressure, hydraulic, oil and acid service. The "John Crane" line has been steadily developing, and to-day any combination of metal alloys for special services can be secured, either in form of a packing or in a gasket.

Fig. 1 tells the story better than any description. It is merely smooth babbitt sheets, thoroughly lubricated, wrapped spirally, forming an all-metallic, flexible, compressible, simple and lasting packing. Fig. 2 shows how "John Crane" looks in ring form and Fig. 3 shows it in coil form. Rings are generally preferred for large plungers, whereas coils are used in smaller work, as in valves, traps, small steam rods, etc.

D. M. Callis, formerly with the Maryland Steel Company at Sparrows Point, Md., and later with the Seattle Construction & Dry Dock Company, Seattle, Wash., has recently been promoted to the position of assistant Northwest district officer of the Shipping Board, under Capt. John F. Blain.



Painting a Wooden Ship With Pneumatic Spraying Apparatus

SHIPBUILDING CONTRACTS

Orders Booked for the Construction of New Ships

The United States Shipping Board has awarded an additional contract to the American International Shipbuilding Corporation for sixty steel steamships of 7,500 tons deadweight each.

The Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., J. F. Tiralla, purchasing agent, has received a contract from the United States Shipping Board to build six steel tank ships of 6,000 tons each.

The Fuller Construction Company, Fuller Building, New York, which will build a shipyard on the Cooper River, between Charleston and Mount Pleasant, S. C., has a contract from the United States Shipping Board to build twelve 9,500-ton steel steamships.

The United States Shipbuilding Company, Portland, Me., is reported to have received a contract to build seven steamships and a number of auxiliary schooners.

The East Coast Shipping Company, Boothbay Harbor, Me., Z. E. Cliff, purchasing agent, is building six three-masted, 165-foot schooners.

The Hartman - Greiling Company, Green Bay, Wis., has received a contract from the United States Shipping Board to build two steel tugs.

The Bayles Shipyard, Port Jefferson, N. Y., will build two ocean-going steel tugs for the United States Shipping Board.

The James Stewart Company, Baldwinsville, N. Y., is reported to have received a contract to build thirty 100 by 37 foot barges, to cost about $10,000 each, the equipment to include hoisting engines for handling freight.

The Terry Shipbuilding Company, Port Wentworth, Ga., will build two 10,000-ton, 500 by 135 foot dry docks, to cost about $1,000,000 each, for the United States Government.

The Manitowoc Shipbuilding Company, Manitowoc, Wis., H. A. Myer, purchasing agent, has received a contract from the United States Shipping Board to build nine more steel steamships.

The Bayles Shipyard, Port Jefferson, N. Y., L. Deyo, purchasing agent, is building four steel steamships for the United States Shipping Board.

The Greenport Basin & Construction Company, Greenport, N. Y., C. R. Brigham, purchasing agent, is building four torpedo retrievers.

The Frank V. Allen Shipbuilding Company, a new concern at Ballard, Wash., is reported to have received contracts to build wooden ships for the United States Shipping Board.

The San Francisco Shipbuilding Company, San Francisco, Cal., has received a contract from the United States Shipping Board, Washington, D. C., to build four 7,500-ton concrete ships.

The Hurley-Mason Company, Tacoma, Wash., Charles E. Hurley, president, is reported to have received a contract from the United States Shipping Board to build several concrete ships.

The Terry Shipbuilding Company, Savannah, Ga., is reported to have received a contract from the United States Shipping Board to build ten oil tank steamships of about 7,500 tons each.

The Savannah Engineering & Construction Company, Savannah, Ga., Wayne Cunningham, president and general manager, has received a contract to build seven wooden towboats for the United States Government.

The Midland Bridge Company, Houston, Tex., George E. Cole, general manager, is building six wooden hulls, with an aggregate tonnage of 21,000.

The Providence Engineering Corporation, Providence, R. I., has received a contract from the United States Shipping Board to build ten 150-foot steel ocean-going tugs.

The Skinner & Eddy Corporation, Seattle, Wash., Henry G. Seaborn, purchasing agent, has a contract to build six submarines for the Electric Boat Company, 11 Pine St., New York, for the account of the United States Navy.

The Delaware Shipbuilding Company, Seaford, Del., is building two wooden four-masted schooners for builders' account.

The Crosby Navigation Company, Richmond, Me., is building a wooden four-masted schooner and will build another as soon as the first is launched.

SHIPPING BOARD AUTHORIZES PRIVATE CAPITAL TO BUILD MOTORSHIPS

150 Wooden Vessels of 3,000 Tons Each to Be Built on Pacific Coast

The United States Shipping Board has agreed to permit private capital to construct 150 wooden ships of 3,000 tons each in Oregon shipyards, each ship to be equipped with Diesel engines and sails, the plan being to use them in the Pacific trade.

The arrangements are said to have been made by Senator McNary of Oregon, in behalf of the newly organized Atlantic-Pacific Corporation, behind which, it is understod, are the Du Ponts, of Wilmington, Del.

Treasury Reduces Ship Insurance Rates

It is evidence of the strongest kind of the effectiveness of the American Navy that Secretary McAdoo is again able to reduce the war risk insurance rates.

The present reduction on hulls and cargoes through the war zone is from 4 percent to 3 percent; the reduction on the officers, masters and crews of merchant vessels through the war zone is from 50 cents to 25 cents per hundred dollars of pay roll. Both reductions took effect March 18, 1918.

The first reduction of insurance rates by the War Risk Insurance Bureau was made last October, when the rate on cargoes was reduced from 6½ percent to 5 percent. The second reduction was on November 23, and was from 5 percent to 4 percent.

PERSONAL

E. P. Worden, formerly chief engineer of Henry R. Worthington Pump Corporation, has resigned to accept the position of mechanical engineer for the Submarine Boat Corporation, New York.

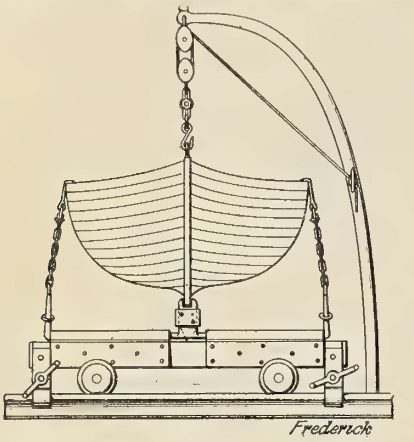
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by George A. Hutchinson, Esq., registered patent attorney, Washington Loan and Trust Building, Washington, D. C.

1,248,183. LIFEBOAT HOLDING AND LAUNCHING DEVICE. FREDERICK W. SIEVERS, OF BROOKLYN, N. Y.

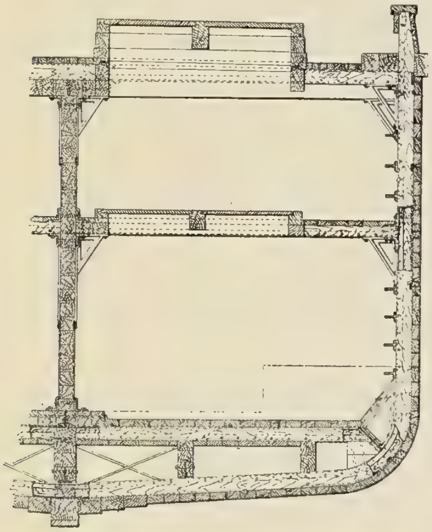
Claim 5.—The combination of a truck, a lifeboat, supporting blocks having pointed lower ends resting on the truck and on the top surfaces of which the keel of the boat rests, rock



shafts on the truck, arms on the shafts, yokes on the arms for normally holding the blocks upright, and means for releasably holding the shafts with the yokes engaged with the blocks, said arms having recesses to engage the keel of a boat when the arms are upright. Seven claims.

1,249,173 NAVAL CONSTRUCTION. LUTHER STRINE MUNSON, OF LONG BEACH, CAL., ASSIGNOR OF ONE-HALF TO THOMAS J. EVANS, OF LONG BEACH, CAL.

Claim 1.—A marine vessel having a steel framework comprising a series of T-beams connected together, wooden timbers secured to the



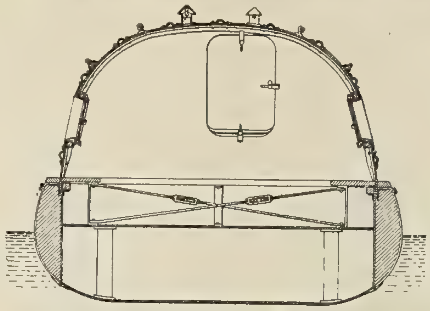
webs of said T-beams by bolts passing through said webs, and planking secured to said beams by bolts passing through the flanges of said T-beams or and said timbers. Ten claims.

1,222,867. VESSEL BULKHEAD. ARCHIBALD HOGG, OF WALKER, NEWCASTLE-UPON-TYNE, ENGLAND.

Claim 1.—A bulkhead construction for ships comprising a transverse bulkhead formed of flat plates and curved plates disposed so that the curves of adjacent plates are reversed, the flat plates lying at the edges of the bulkhead parallel with the crests and valleys of the curved plates, the arc of each plate curve being limited in extent to not more than one-third of a circle and the width distance between adjacent curve crests exceeding four times the depth distance from crest to reversed crest, flanged joints between said plates and curved plates, and a continuous four-sided boundary frame comprising at least one angle bar, two sides of said frame being formed with broad shallow undulations which enter the undulations of the curved plates of the bulkhead, said frame being attached on all four sides both to the bulkhead and to the hull of the ship, all as set forth in the specification. Six claims.

1,249,645. LIFE-BOAT. ANDREAS P. LUNDIN, OF BAYSIDE, N. Y.

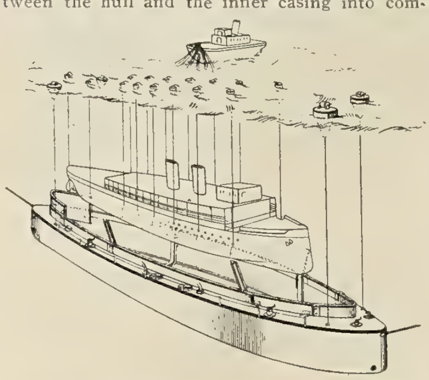
Claim 1.—A life boat embodying a hull having a well and a housing erected above said well, entrance and exit ports provided with



watertight closures, side ports having row-lock notches formed in their lower edges and a glazed watertight closure for each of such side ports and notches. Three claims.

1,250,787. MEANS FOR RAISING SUNKEN VESSELS. GÉDÉON BREAULT, OF PAWTUCKET, R. I.

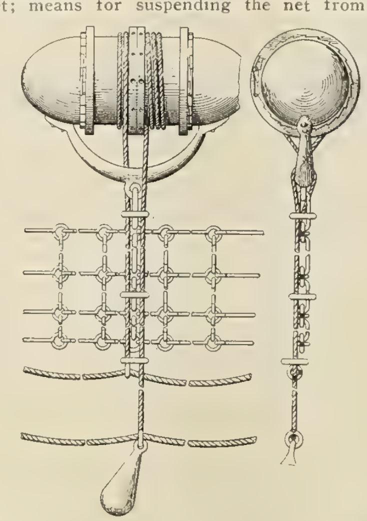
Claim 1.—A floating dry dock comprising an outer hull, an inner casing spaced from the hull, a deck holding the inner casing in spaced relation, partitions for dividing the space between the hull and the inner casing into com-



partments, a valve for permitting the entrance or exit of water from each compartment, means for operating each of said valves individually, means for forcing compressed air into or permitting the withdrawal of air from each compartment individually, and U-shaped guide members spaced within the inner wall, the upper ends of said U-shaped guide members being outwardly flared. Four claims.

1,251,326. TRAWLING DEVICE. GEO. PELL, OF OROVILLE, CAL.

Claim 1.—A trawling device comprising a net; means for suspending the net from the



surface of a body of water; a pair of horizontally disposed cables operatively connected to the suspending means; and means for independently altering the distance between each cable and the net. Fourteen claims.

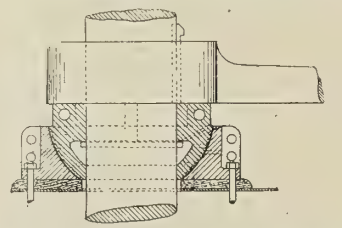
1,205,766. BOAT-LAUNCHING DEVICE. ALLEN E. J. LUCKHURST, OF RIDGEWOOD, N. J.

Claim 1.—In a boat launching device, gearing mounted on the davit adapted to rotate the same, means carried by said davit to operate said gearing, and means independent of any operating parts to hold said operating means in fixed relation to the ship. Nine claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

110,002. "IMPROVEMENTS IN AND RELATING TO SHIPS' RUDDERS." C. A. JACKSON, SUNDERLAND.

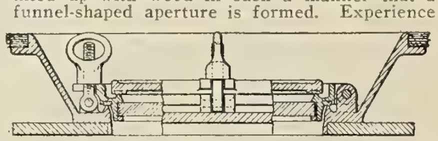
A rudder carrier or bearing in accordance with this invention is characterized in that the deck plate or ring is formed with a part spherical bearing surface adapted to receive and support a corresponding part spherical bearing sur-



face on the stock ring and is further characterized in that the stock ring is provided with a cavity or cavities for lubricant and with means for forcing out said lubricant through suitable passages onto the bearing surfaces.

110,510. "IMPROVEMENTS IN OR RELATING TO SIDE SCUTTLES FOR SHIPS." R. G. CERVIN, OF STOCKHOLM, SWEDEN, AND B. SILFVERLING, OF ARBOGA, SWEDEN.

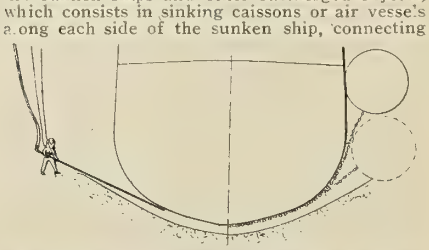
Scuttles usually consist of a window hinged in a frame firmly connected to the outside plating, the space between this frame and the ceiling inside the outside plating being usually filled up with wood in such a manner that a funnel-shaped aperture is formed. Experience



has, however, shown that this arrangement is not at all satisfactory, because the water and the moisture from the scuttles without difficulty make their way between the outside plating and the ceiling, thus causing the corrosion of the former below the scuttles, making it necessary often to inspect this part of the outside plating. According to the present invention, the frame is united or made in one piece with a flange extending from the frame to the ceiling, and is preferably of an annular, conical shape, thus preventing the water from the window from making its way between the outside plating and the ceiling. Hereby the inconvenience above stated is removed.

109,097. "IMPROVEMENTS IN OR RELATING TO THE RAISING OF SUNKEN VESSELS, SHIPS AND OTHER SUBMERGED OBJECTS." A. G. MIDFORD, OF OTTAWA, CANADA.

This invention relates to the method of raising sunken ships and other submerged objects, which consists in sinking caissons or air vessels along each side of the sunken ship, connecting



them together by means of chains or the like passed through channels beneath the ship, and then admitting compressed air to the caissons. An essential feature of the invention consists in the improved manner in which the openings or channels in the soil beneath the ship are formed for the reception of the chains, by boring means adapted to permit of hydraulic or pneumatic pressure being applied alternately and successively to the subsoil, said means being worked from either side and the chains being passed beneath the ship prior to connecting them to the yoke-pieces on the caisson.

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Progress in Shipbuilding

AFTER months of disheartening delays American shipyards are beginning to strike their gait. Most of the preliminary work begun last year in establishing new yards has been completed and construction of vessels on the new ways is now rapidly forging ahead. Before this issue reaches our readers the first vessel from the new government assembling yards will have been launched by the Submarine Boat Corporation at Newark, N. J. The wooden shipbuilders are now setting a pace of one ship a day. During April the American merchant marine was increased at the rate of a little over 9,000 tons a day, making the total output for the month 240,000 deadweight tons. In the first twenty-three days of May twenty-nine merchant vessels were completed, totaling 174,662 tons. Up to May 11 a total of 159 vessels of 1,108,621 tons had been completed in American shipyards, so that the first million tons of shipping built under the direction of the United States Shipping Board has been placed in service. More than half of this tonnage was delivered since the first of this year and the monthly output is steadily increasing. With continued improvement in the delivery of shipbuilding materials and satisfactory handling of the labor, housing and transportation problems, it will not be surprising if the total output of merchant tonnage from American yards for the year passes the 3,000,000 mark and approximates 4,000,000 tons.

With the expectation of increasing the output from 50 to 60 percent during the coming year Director-General Schwab is encouraging the expansion of existing shipyards and the establishment of new ones. The yards on the Lakes will have an opportunity to increase their output by a million tons and contracts will probably be placed with Pacific yards for at least a million and a quarter additional tons. There will be no reduction of wooden shipbuilding. On the contrary contracts for wooden ships of the Daughtery and Ballin types will be doubled. All of the steel yards on the Atlantic and Gulf coasts will be given all the work they can handle and in many cases the facilities at the yards will be increased. At the Bethlehem Steel plant at Sparrows point, $2,000,000 (£410,000) will be expended immediately for building four new ways and the working force will be increased by at least 4,000. The Newport News Shipbuilding & Dry Dock Company, which has over $100,000,000 (£20,500,000) worth of Government work under contract, is making improvements and extensions at a cost of nearly $6,000,000 (£1,230,000). This yard now employs 9,500 men, which will be increased to 12,000 by the end of the year and to 15,000 within a year. Five government yards for concrete construction will soon be established. A fleet of barges aggregating 775,000 tons and over a hundred tugs will also be built. With the vast amount of work contracted for or pending there is only one answer that the shipbuilders can give—that is, increased efficiency and speed. The outcome of the war depends upon it and it will be forthcoming, we believe, in full measure.

Reduction of Merchant Shipping Losses

SINCE October, 1917, the tonnage of merchant steamships of 500 gross tons and over entering and clearing British ports from and to ports overseas (except coastwise and cross-channel) has averaged nearly 7,000,000 tons a month, and in March exceeded this figure. The losses of British, allied and neutral tonnage during the last five quarters (beginning with January, 1917) has been as follows: 1,619,373; 2,236,934; 1,494,473; 1,272,843 and 1,123,510, which shows a steady decrease during the past year. In recent months the decrease has been even more marked, the highest being 893,877 tons in April 1917 and the lowest 305,102 in April 1918. Comparing these figures, which were supplied by the British Admiralty, with shipbuilding reports from the allied countries it is apparent that ships are now being built faster than they are being destroyed by the German submarines. Moreover, the rate of destruction of the submarines themselves has steadily increased during recent months. This outcome, confidently predicted months ago by American naval authorities, is confirmed in the recent speech of the British Premier. When the history of the allies' warfare against the submarine is made public the deeds of both naval and merchant officers and crews will form one of the most brilliant chapters in marine annals. At the present time it can only be said that the work of these brave men is held in the greatest veneration and with just pride by the nations they are serving.

Shipbuilding Rivalry

NO better incentive for speeding up shipbuilding could be offered than the keen rivalry which now exists among the shipyards for establishing new records in fabricating, assembling and launching vessels for the Emergency Fleet. Foremost among the records made last month was the building of the 5,000-ton collier *Tuckahoe*, by the New York Shipbuilding Corporation in Camden, N. J., in the phenomenal time of 37 days. Under the expert direction of Thomas Mason, superintendent of the yard, this vessel was launched 27 days after the keel was laid and delivered to the Government completed in 37 days. This feat establishes a world's record in vessel construction, the best previous record in this country having been made at the Skinner & Eddy yard in Seattle, where the 8,800-ton steel freighter *West Lianga* was launched 55 days after laying the keel and completed in 71 days after construction was started.

New records in riveting are being established every week, and in this work shipbuilders in Great Britain are at present setting the pace. The latest record at this writing is held by a workman at the Vickers Naval Construction Works at Barrow, who drove 5,804 rivets in nine hours. Closely following this, word comes from a San Francisco shipyard claiming a record for one of its workmen of 5,629 rivets in nine hours, exceeding the best previous record in this country made by Charles Knight, a negro employed at the Bethlehem Shipbuilding plant at Sparrows point, Md., who drove 4,875 rivets in nine hours. Records are also constantly being made in other kinds of work, such, for instance, as the laying of the keel of a 3,000-ton wooden vessel in 1 minute and 45 seconds after a vessel had been launched from the same shipway, at a yard of the Foundation Company on the Pacific Coast.

While such spectacular achievements are not an exact gage of the extent to which shipbuilding work is being speeded up, nevertheless they show what can be done under the conditions where every energy is directed to reducing the time for building a ship, and, therefore, should be encouraged in every possible way.

The Juniors' Prize Papers

NOW is the time for the junior members of the Society of Naval Architects and Marine Engineers to collect material for the preparation of scientific papers to be entered in competition for the hundred dollar prize offered by H. L. Aldrich, associate member of the Council of the Society of Naval Architects and Marine Engineers, for the best paper written by a junior member of of the society for its annual meeting in November. All papers entered in this competition must be completed and delivered to the secretary of the society on or before October 15. As the prize will be awarded to the author of the best paper submitted, or divided into two or possibly three prizes, as may seem best, depending upon the quality of the papers submitted, it is anticipated that the competition will be keen. The papers are not limited to any definite subjects, but may deal with any phase of shipbuilding or marine engineering, either merchant or naval. A wide field is, therefore, open for junior members of the society to develop ideas which will prove of real value in the development of shipbuilding.

Concrete Ships

THAT concrete shipbuilding will form an important part of the Government shipbuilding programme seems assured by the success which has attended the recent trials of the 5,000-ton concrete steamship *Faith* now in service on the Pacific coast. Reports from the official trials of this vessel indicate that the expectations of the builders will be fully met as to the strength of the reinforced concrete hull to resist the stresses imposed by service in the open sea. The vessel not only exceeded her contract speed by over a knot but developed the further advantage in a very appreciable reduction of vibration in the hull. As a result the builders of this vessel have been awarded a contract for a 7,500-ton ship of similar construction.

Contracts have now been placed by the Shipping Board for a total of 58 concrete vessels, aggregating 417,500 tons, at an approximate cost of $42,250,000 (£8,670,000). Forty of these vessels are of 7,500 tons and will be built in five Government yards.

LETTER TO THE EDITOR

Wooden Auxiliary Schooners

There has been much talk and much criticism in connection with the building of wooden auxiliary schooners. Making use of the space kindly offered me by the editor of this paper, I venture to make a few remarks from a *commercial* point of view.

From our own personal experience we know what splendid service the wooden sailing vessels rendered years ago. As an example, in the eighties, one of these ships, a clipper of 2,800 gross tons, carrying 27,000 barrels of petroleum, made a record trip from New York to Antwerp, and from Quebec to London in twelve days. On account of the immense shortage of tonnage, wooden ships are again called upon. The idea of installing reliable crude oil engines in sailing vessels has been carried out and the engines have given very good results in steel square riggers, as well as steel fore and aft schooners, and should easily be advantageously adopted for the *wooden* schooners.

This combination, however, points to a matter which is of utter importance, namely—*workmanship*. Owing to the immense demand for tonnage, yards have been established and the work has been carried on by non-competent and in some cases unreliable men. This circumstance has caused more trouble than many seem to realize. The results are not only inferior work, making use of green timber, bad rigging and poor installation of engines, etc., but the immediate result has been that the yards have gone into bankruptcy, thereby causing incalculable delays, increased cost of the vessels and all kinds of trouble.

In many cases, where foreign enterprise, such as Scandinavian, has been left to the judgment of their agents in this country, severe losses have been the result, owing to circumstances mentioned above. Personally, I know of not less than three yards which went into bankruptcy proceedings, being absolutely unable to fulfill their contracts. The foreign owners have thus been forced to take the yards over and complete the vessels at considerably increased cost.

As pointed out before, there is no reason why the wooden auxiliary schooners should not prove a first-rate useful cargo vessel. Extraordinary circumstances should, however, be kept in mind, such as the use of green timber in many of the vessels, and it consequently would be advisable for the first two or three years to employ the vessels in a suitable trade. As such, there is none as suitable as the Pacific and the Eastern trade. I look upon the wooden schooners as the most useful tonnage in the trade between Pacific ports and Australia, the Hawaiian Islands, and the Far East, preferably, though, in a trade where they do not have to cross the equator. They will thus be able to release for the *transatlantic* trade the tonnage so badly required—fast-going steamers.

The auxiliary wooden schooner possesses many advantages, such as a comparatively small crew, seaworthiness in most kinds of weather and economy in operation. As regards the latter, however, much depends upon the rate of insurance, and the insurance companies will have to alter their opinion of the quality of these vessels. Practical results obtained in the trade will soon prove the efficiency of the wooden schooners, which no doubt will form one of the great helping factors in winning this war.

Seattle, Wash. FRIDTJOF BRYDE.

Merchant Shipping for the War and After

Discussion at Convention of National Foreign Trade Council in Cincinnati Centers on Ships and Shipping

THE one most important matter discussed at the convention of the National Foreign Trade Council, held in Cincinnati, on April 18, 19 and 20, was ships; and the manner in which this was evidenced was conclusively convincing of the fact that American business men are at last awake to the vital necessity of more and more shipping. With President James A. Farrell, of the United States Steel Corporation, chairman of the Council, presiding, and about 1,400 of the leading business executives of the country attending and participating in the business of the convention, nearly every subject discussed touched upon shipping in one form and at some angle; while the third general session, that of Friday, April 19, was devoted exclusively to the subject of the American merchant marine.

Men familiar with foreign trade conditions, and with the peculiar needs of given industries, told the members of the Council how the business of this country abroad after the war will depend very largely upon the extent to which the construction of an adequate merchant fleet is taken care of. Such details as the fostering of the country's inland waterways, the development of American marine insurance, and others, were discussed as necessarily bearing upon the general subject; while the fundamental and immediate necessity of building and maintaining enough ships to take care of the needs of the Allied and American armies in France, and at the same time to see that the needs of the rest of the world, as far as this country is concerned, are not neglected, were points brought out with vigor and clearness.

A telegram from E. N. Hurley, chairman of the United States Shipping Board, who was unable to be present in person, fittingly summarized the importance of shipping. After declaring that the place of America in the future is in the forefront of the world's commerce, he said:

American Ships in the World's Commerce

"We are building ships first and foremost for the war, but they will be useful for the future world trade as well. Remember that once their part in the winning of the war is ended a large number of them will be engaged in bringing back to home and industry the victorious soldiers, and in transporting to Europe the materials necessary for reconstruction of normal life, freed from the menace of avaricious autocracy. These vessels will serve the commerce of other nations equally with our own, their facilitations of the trade of the world will be the corollary of the freedom of the seas we fight to assure. And if there are any men among you who doubt that we are going to have a vast fleet, I will simply ask whether you have heard of a well-known man in our organization whose name is Charles M. Schwab."

A striking address on the subject of shipping, dealing with its important connection with the Pacific overseas trade and the present predominance of the Japanese there, as well as in the American coastwise trade, was delivered by Wm. D. Wheelwright, who said, in part:

"The extension of our trade depends primarily upon ships, but in only slightly less degree on the return cargoes, preferably of raw products, which must be had if ships are to run economically. Obviously, when a ship which carries our goods to Japan or China has to come back in ballast, the entire cost of the voyage must be borne by the outward cargo. This reduces the money value of our products to the extent of the extra freight, which at present shipping rates, unlikely to decrease materially for some time after the war, often determines whether we can afford to make a shipment.

"But there is another reason for our cultivating or originating a west-to-east business across the Pacific. We will be confronted at the conclusion of peace terms with the problem of the status of laborers, who have for years been employed on war work, and that of soldiers whose occupations will have gone. For the sake of the existence of our social order we must find remunerative employment for the great number of men who will soon after the war be seeking it. It is largely to handling and manufacture of raw products that we must look for employment of these men."

Pacific Shipping

"Under these conditions," Mr. Wheelwright continued, "the Japanese have come very near a monopoly of the carrying trade of the Pacific. They control not only established lines, which are supposed to carry freight for all shippers at fixed rates without discrimination (which they never do), but by tramp steamers, whose owners or charterers are also buyers and sellers of the cargo. One can hardly speak too highly of the energy and capacity of the Japanese, so you may ask yourself what chance an American has to compete with them in trade when he is dependent upon them for transportation!

"The United States Government will own enough ships to rehabilitate the ocean commerce of the country, if only the nation will continue its ownership and let the ships out to its citizens on fair terms. The sale of the ships would mean their immediate transfer to other flags, except as they could be used in coastwise trade, and would put an end forever to our hopes of a great maritime fleet operated under the Stars and Stripes. For, outside of coastwise trade, there would be no competition between foreign and American buyers, and the foreigners would get the fleet at their own price, and use it to perpetuate the exclusion of American citizens from the maritime trade of the world."

Growth of the Oil Fleet

Comment upon the enormous expansion of the petroleum industry since the war began, made by A. C. Bedford, chairman of the board of directors of the Standard Oil Company, of New Jersey, carried with it an explanation of the attendant increase in the size of the tanker fleet carrying oils abroad, and the gratifying news that still further expansion is going on. In this connection, Mr. Bedford said:

"We had amply provided for the needs of our trade abroad, but the first and unsurmountable obstacle has been our limited tank steamer mercantile marine, which has not been sufficient to transport war requirements and take care of these markets as well. There lies a problem that the war, both before and since America's entry into it, has brought out in sharp relief. In those faraway days, when there was no war, the exports of oil products were carried almost entirely in tankers of British, German, Dutch and Norwegian registry. America had very few

tank steamers flying the American flag. After the outbreak of the European conflict a number of German tank steamers were transferred to the American flag, and these to-day constitute an important part of the American fleet. A proportion of the British fleet of tank steamers was commandeered by the British Government to transport their requirements. The result was that it has not been possible to supply all the demands of the Allies and also the neutral nations."

Development of American Merchant Marine Necessary

"*This situation constitutes a strong argument for the development of the American mercantile marine.* Germany's relentless submarine warfare has emphasized this necessity, and the time has come when American shipowners must be given an opportunity of competing on equal terms with other nations, in the carrying trade. To the fulfillment of this ambition, dear to the heart of every American, the oil trade has already made some substantial contribution. On the outbreak of the war, orders for tankers were placed in large volume. The result is that while in 1914 the gross tanker tonnage flying the American flag amounted to 278,753 tons, the building programme has steadily expanded until at the present time our tanker tonnage amounts to 1,106,754 tons. The necessity of maintaining and upbuilding a merchant marine of this kind was recognized by the Shipping Board, with the result that still more tankers are being built, and we shall be better equipped than ever in the present year to fulfill all requirements for the prosecution of the war."

One address, that of M. E. Farr, president of the American Shipbuilding Company, of Cleveland, dealt wholly with the matter of shipbuilding, and should therefore be of special interest. It was brief, but very much to the point, dealing, as it did, with the essentials of the industry as it now stands. The address was as follows:

Essentials of the Shipbuilding Industry

"One of the greatest tasks confronting the world today is the replacing of ocean tonnage destroyed or incapacitated for use, through war operations. The sinkings of vessels by submarines do not represent the total destruction of deep-sea tonnage. The normal wear and tear, and the losses through collision, stranding and from other causes, incident to operation under war conditions, have greatly reduced the world's tonnage. All of this tonnage must be replaced by the shipbuilders of the world, principally by Great Britain, Japan and the United States.

"At the present time the energies of these countries are directed toward providing sufficient merchant tonnage to meet the war requirements and necessities of our Allies. That our part of the undertaking will be performed there is little doubt, and at the same time a solid foundation will be laid for the development and protection of our foreign trade. In order to accomplish this vast programme, the shipbuilder must have a free hand, unhampered by laws, restrictions and exacting requirements frequently imposed by Government agencies, and he must also have the earnest co-operation of the Government, labor, mills, and such manufacturers as are able to produce materials and equipment entering into the construction of steel and wooden vessels. Private enterprise and initiative in shipbuilding and shipowning should be encouraged and fostered by our Government.

"The urgent demand for ocean tonnage from foreign interests during the past two years led to the establishment of a large number of American shipyards, and the enlargement of existing concerns. This prepared the way for and gave stimulus to create greater capacity to produce ocean tonnage. Our entrance into the war further increased these activities. Three shipbuilding plants of large capacity are now in course of construction by the United States Shipping Board.

"All the available shipbuilding skill and talent has been assembled to carry out a vast program of ship production. Special tools and equipment, far beyond the capacity of American makers, were necessary, and were, therefore, not immediately available. On account of the limited supply of technical shipbuilders and skilled workmen and lack of equipment, nearly every new plant has been delayed in getting under way, and ship construction work in the plants of going concerns has been retarded on account of the loss of important men to the new enterprises.

"It is essential that shipbuilding plants be located where favorable weather conditions prevail, where the climate is equable and housing conditions are ample and good, and where an adequate supply of skilled, semi-skilled and common labor is obtainable. It is also important that such plants be situated on direct rail lines tapping fuel and material supplies, and in localities where economies in construction costs can be brought about.

Foreign Competition

"In order to compete with our foreign rivals after the present war is over, we must be able to produce ships equal in quality, cost and economy in operation, or lose in the race for maritime supremacy of quality. The American shipbuilders must, therefore, prepare for the strong competition by providing their plants with modern tools, machinery and equipment, and, what is still more important, by creating technical and operating organizations of the highest order and efficiency.

"Our leading post-war competitors will be Great Britain, Japan and Germany, although other countries will take an important part in ship production. The great potential resources in labor and material in countries not heretofore engaged in shipbuilding, may yet be developed, and these nations become powerful factors in ship production.

"The most reliable reports now obtainable show that the production of new tonnage overbalances that destroyed. A large amount of new American tonnage will soon be available, and production will rapidly increase in volume until an ocean-carrying capacity is provided fully ample to meet war and commercial requirements.

Comparison of Labor Costs

"Owing to high wages and the prevailing standard of living, construction costs in this country are excessive and compare unfavorably with conditions in Great Britain and Japan. The average daily wage for a nine-hour day in Great Britain and a ten-hour day in Japanese yards compare with the present wage for an eight-hour day in leading American yards, as follows:

	Great Britain, Dec. 1917.	Japan, 1917.	American.
Skilled	$2.16 to $2.79 (9/0 to 11/5)	75c to 90c (3/1½ to 3/9)	$5.80 (1/4/2)
Semi-skilled	$1.94 (8/1)	70c (2/11)	4.40 (18/4)
Unskilled	$1.81 (7/6½)	60c (2/6)	8.20 (18/4)

Piecework rates in American yards are proportionately higher.

"The standardization of ships has come to stay. This standardization may be applied to the conventional or the fabricated type. Variations in size and arrangement of steamers are necessary in order to meet the requirements of special trades and commodities, but in any event the

ship should be of standard design. Recent reports concerning concrete ship construction are encouraging, and it is hoped that this method of construction will stand the tests of service and become an important factor in our merchant marine.

"A committee consisting of representative shipbuilders, similar to the council associated with the British Admiralty, would be of great assistance to such of our Governmental agencies, as are concerned in the production of merchant ships.

"While the production of ocean tonnage may not have fully come up to the hopes and expectations of many, it must be remembered that the shipbuilding industry in America is in process of development, and the construction programme of the Navy and the shipping board is vastly greater than ever undertaken by any nation.

"Within the next few months the country will possess scores of shipyards, fully equipped for the production of both steel and wooden ships; mills with more than ample capacity to provide materials; and in sufficient skilled labor to enable us to continue a maximum of ship production. The unselfish co-operation of these interests is essential, if we are to successfully meet the certain competition of the future."

In view of the unanimous appreciation of the absolute necessity for fostering the merchant marine in every way possible, the adoption of certain clauses bearing on the subject, in a general declaration of principles presented for the approval of the convention by central convention committees, was not surprising; and these statements, embodying, as they do, the settled sense of such a large and influential body of American business men, promise well for the future of the American merchant marine, both in the improved position of the shipbuilding industry, in the minds of the public, and in the consequent hope for better treatment by the Government.

"The imperative need of the hour," ran these resolutions, in part, "is the presence in the North Atlantic of as great tonnage as can be handled in military transport without weakening the lines of supply of our forces which originate in all the non-European markets. Sacrifices necessary to this end will be gladly borne. The members of this convention, individually, and through the National Foreign Trade Council, stand ready to place at the Government's disposal their experience and information, to the end that the determination of the essential character of the various trades and the necessary curtailment of exports and imports shall be both practical and effective.

"A merchant marine is being created of tonnage sufficient, ultimately, to provide for the maintenance of necessary exports and import trade during the war, and for any reasonable expansion of that trade after the war, *provided that extra war costs of construction be readjusted to accord with the costs (with due allowance for depreciation) of the competing shipping of foreign nations after the war. Allowance also must be made for any extra costs of operation of these American steamers by reason of any handicap imposed by our shipping laws as compared with those of other nations.*"

Training Shipyard Workers by Emergency Fleet Corporation Methods

Carefully Selected Mechanics Taught by Skilled Instructors How to Impart Their Knowledge to Green Men—Production of Skilled Workers Imperative

BY R. V. RICKCORD

THERE can be no doubt that all but a negligible number of the men who know anything about shipbuilding are now engaged in the shipyards. The labor requirements for the country's shipbuilding programme are said to amount to a quarter of a million, in addition to those so engaged. It therefore goes without saying that the only means of building up this force is by training either green men or men who have allied trades. Because of the various methods which can be utilized in this undertaking, the shipbuilder has found himself in a somewhat puzzled situation. It has at least been necessary for him to experiment in order to find out the best method. As a separate consideration, there is, of course, the possibility of hiring ready-trained men from other yards; this aspect of the case, however, will not be discussed here, since the policy is so evidently a suicidal one that it is likely to be stopped by agreement between the shipbuilders themselves in co-operation with the Emergency Fleet Corporation. It is, on the other hand, quite obvious that every yard which is organized from now on must start with a nucleus of shipyard tradesmen, which cannot but come from other yards.

There has been no doubt concerning the desirability and importance of training men right in the yard, but on the question as to how this should be done the shipbuilders seem to be divided into two camps, the one holding the opinion that it is best to put the man right on the job, usually as a helper, and to depend upon the foreman or skilled worker to teach the learner the trade in addition to his doing regular work; and the other advocating that an instructor, either trained or untrained, be set aside, whose job it is to train the new man and to do nothing else—to regard his job as being not the production of the vessel, but the production of the skilled worker. The first method depends upon the good will of the foreman or the mechanic, and really makes him a philanthropist. The second method is the one advocated by the Industrial Training Department of the Emergency Fleet Corporation.

In developing emergency training methods for shipyards, the following facts were taken into consideration:

1. The only man who can teach a trade is the skilled mechanic who works at that trade.
2. The skilled mechanic is not usually a skilled instructor.
3. The skilled mechanic may be trained to become a skilled instructor.
4. Emergency training demands that the instructor be

skilled to give effective training in the least possible time.

It will be seen by examination of these four features that the instructor who is without training is at a disadvantage.

The turning of a shipyard tradesman into an instructor may look like a formidable undertaking; but, after having trained some three hundred and fifty men, the Industrial Training Department of the Emergency Fleet Corporation has not found this to be the case. It should be recognized that it is impossible for the instructor to teach the new man anything, the distinction is rather that the new man must teach himself. If information can be given to the mechanic whereby he stimulates a desire within the new man to learn a trade and whereby the new man unconsciously teaches himself, a long step can be taken toward the making of a successful instructor.

A Typical Group of Shipyard Mechanics Learning to Be Instructors. From Ten to Twelve Men Are Handled by an Expert Trade Teacher.

The Emergency Fleet Corporation does not undertake to teach the various shipyard trades; the actual teaching of the trades can best be done in the yards where the men are needed. The suggestion has been made that all the men be trained in one place and supplied ready-made to the shipbuilders. This is equivalent to saying that all the ships required in the present programme be built in one yard. The real difficulty has been, not in obtaining men who knew enough about their trade to teach it *somehow or other*, but in equipping such men with information that will enable them to teach efficiently.

Under the arrangement made by the Industrial Training Department the shipyards seeking co-operation in the matter of training are expected to anticipate their future labor requirements and also to divide these needs over the various shipyard trades. Prospective instructors are chosen for the various trades; the choice of these men is left to the shipyards. The general qualifications for a prospective instructor are that he should at least be a sufficiently good mechanic to command the respect not only of the learner, but of other mechanics in the yard. Some of the best instructors have proved to be men with very little general education. The training period is six weeks, which may be spent either in an established center, like that at Newport News, or, if there are a sufficiently large number of instructors required in any one yard, arrangements may be made for placing an instruction center in that yard.

One of the first steps in the instruction process is that of teaching the artisan to divide up his trade into a series of steps so that like jobs in that trade are kept together and only samples of each type given to the new man. This locates every job in the trade and prevents any more repetition than is necessary in teaching. It also enables the trade to be laid out in a series of jobs progressively increasing in difficulty; this makes for a certain smoothness of instruction. What is not generally recognized by the shipbuilder is the fact that the art of instruction—"putting it over," or teaching the other fellow the trade—is an art by itself, and one usually requiring more study and a much more scientific approach than the learning of the shipyard trade itself.

Other subjects which are presented to the prospective instructor are the organization of a training department, the processes whereby a new man settles down to the job, the development of interest within the new man whereby he more easily learns what is given to him—in fact, the whole problem of instructing, holding and caring for the new man is more or less thoroughly considered as part of his training.

The tradesman at the training center for instructors is placed in a group numbering about twelve men; the instruction is given by an expert trade teacher, who may not necessarily be a shipbuilder. After the prospective instructor has studied the objective aspect of "putting over" the trade he gives a series of practical lessons. For this purpose a group of green men are supplied to him from the yard and he teaches his trade to these men under the stimulating influence of the shipyard workers in his group. This usually has the effect of inducing the man to be very careful what he says and does; he is often combative to an extent commensurate with the critical nature of his fellow-students. The result is wholesome for all concerned, and certainly not unfriendly.

Mr. Homer L. Ferguson, of Newport News, is to be thanked, not only for installing the industrial training center in the yard of the Newport News Shipbuilding & Dry Dock Company, and for extending his moldloft in order that it may be accommodated, but also for the supply of green men on the vessels when and where they are needed and for specific jobs in order that these men may be trained.

The Expert Trade Teachers Are Loaned by Cities in Many States. Among the Cities Supplying Trade Instructors Are: Trenton and Newark, N. J.; Buffalo, Elmira and New York, N. Y.; Somerville, Quincy and Boston, Mass.; Seattle, Wash.

By the time the prospective instructor finishes his six weeks' training his viewpoint is changed from that of a tradesman whose idea is to progress with the job to that

of an instructor whose idea is to produce the tradesman from new material.

Against the putting of a new man with a trained instructor is the method, which has already been touched upon, of putting him with an experienced tradesman as a helper. The disadvantage of this lies in the fact that the new man is limited to the particular job or jobs the skilled man happens to be doing. In any case, there is usually no actual teaching, but rather a looking-on process.

If the new man is put with an instructor whose job it is to do nothing else but instruct, but who, nevertheless, is untrained, these disadvantages are still likely to occur.

Under the circumstances, the most efficient method of handling new men is probably through a specially organized training department, the work of which is independent of the production department. The training department should consist of a director and instructors, whose number will depend upon the requirements of the trades for which it is considered necessary to train men. The training department may be responsible to the general manager, superintendent or other executive officer, depending upon the yard organization. The steps in the employment and training of a new man should be as follows:

Original Group of Shipyard Mechanics Sent to Newport News Training Center for Instruction to Enable Them Most Efficiently to Teach the Various Shipyard Trades

Unless there has been a regular analysis of the trade, easy and difficult jobs are likely to be given promiscuously, the various operations shown rather than taught, and some uncertainty will exist as to whether the learner really knows the job; all this tends to lengthen out the period of instruction and to make it inefficient. In any case, there is usually very little attempt made to stimulate the learner to think for himself. No doubt the untrained instructor does exceedingly well sometimes, but the trained instructor is conscious of his aim, and is thus likely to be systematic in the turning out of his product—the skilled mechanic.

If the method of placing a green man with a foreman or with a tradesman for instruction is at all successful it means that a certain amount of the foreman's or the tradesman's time has been absorbed in the teaching process. This time should be given entirely to the production of ships. Much less time will be spent per man if an instructor is told off to do nothing but train, say ten, learners at a time.

1. Foreman sends requisition to employment department for a man in any one trade.

2. The new man is secured and sent to the foreman for his approval.

3. Foreman returns man to employment department with his approval.

4. The man is sent to the training department with the requisition that he be trained in the trade called for by the foreman.

5. The new man is placed under an instructor on the vessel. The foreman supplies the jobs specified by the instructor, but has nothing to do with the giving of instruction. The instructor trains the learner "on the job."

6. When the learner knows enough about the trade to be trusted alone, he is returned to the employment department.

7. The employment department sends the man to the foreman who originally sent in the requisition.

8. The foreman puts the man on the job.

Some of the largest yards in the country are employing

Training Center in Session, Showing Groups at Work

The building shown in the picture is an extension of the moldloft at the works of the Newport News Shipbuilding & Dry Dock Company, which was extended by Homer L. Ferguson, president of the company, to enable the Emergency Fleet Corporation to do the work of training shipyard trade instructors.

this method. For one of the large shipyards on the Atlantic coast no less than eighty instructors have been trained by the Industrial Training Department.

It would be well perhaps at this point to consider the limitations of evening schools as training centers for shipyard workers. In some localities very effective work is being done in these schools, particularly where the instructor is also the shipyard foreman or superintendent. This condition enables him to keep in contact with the learners, to see the difficulties the learner has to contend with, to discuss those difficulties during the evening class, and to see that they are removed during the next day. Good recruiting work is being done in a certain evening class in practical riveting. The class attracts men of other trades in the locality, who, if they prove sufficiently capable, are given an opportunity to learn the trade in the shipyard at good wages under trained instructors and actually on the vessel.

Evening-School Work Inefficient

But in spite of this, evening school work does not systematically, consecutively and efficiently *teach the trade*. The conditions are usually that equipment is lacking, the teaching period is short, the student is not in the best physical condition for absorbing the subject, and, after a day's work, the teacher is not primed to do his best.

Evening school instruction is nearly always in the nature of auxiliary information, useful hints about the trade, discussion as to how the job should be done, talks on the use of tools and material, the application of formulæ and tabulated information, but not usually actual practical experience in doing the job.

In considering the reasons why this information should rather be given while the job is actually being done in the yard or on the vessel, it should be remembered that evening school instruction is usually given to a group of men in a class-room, and that the individual members of a group are given the same information.

Why Instruction Should be Given "On the Job"

As likely as not these students will be in various stages of advancement in their trades even if, for class purposes, they are divided up into sections—elementary, intermediate and advanced. The instruction given, therefore, will not be of direct or immediate application, but rather is intended to be useful sometime in the near future, and a period will elapse before the learner needs to use it.

The disadvantage of this is twofold; first, the student is not so keenly interested as he would be if the information related directly to the job he happened to be doing; and secondly, he is likely to forget it because of the period of time which elapses.

In view of the difficulty of obtaining shipyard workers and the tendency of using men who have allied trades, the Industrial Training Department has also undertaken the work of training "conversion" men. Given a man with an "allied" trade, say, a structural iron-worker, of whom it is proposed to make an instructor in a shipyard trade, the scheme is to give him the regular instruction for an instructor and in addition as much actual experience in shipbuilding and information about the shipbuilding trade as will make him a man who can instruct in that trade. As an instructor of men who are from his old trade, he has the advantage of knowing the difficulties that these men have to contend with in learning the new trade.

Some of the wood shipbuilders are taking advantage of this scheme to convert good house-carpenter foremen into

(*Concluded on page* 361.)

Ferro-Concrete Ships*

Comprehensive Discussion of Materials and Systems of Construction—Plastered and Molded Ships—Weight, Cost and Durability

BY T. J. GUERITTE, ING. E. C. P.†

TO judge by the surprise evinced in the daily papers when the first reports were published a few months ago of the great impetus given by the war to ferro-concrete shipbuilding activities, one might have imagined that there was something startlingly new in the idea, and much nonsense was printed at the time, under big headlines. And still the last few years have merely seen the development of activities dating from many years back. It is, in fact, a curious coincidence that it was the author's privilege to deliver a paper entitled "Ferro-Concrete as applied to Floating Structures" in the year 1908, before one of the Newcastle building trades associations, the matter of which formed the basis of many of the articles which were published on the subject during the last few months. The conclusions of that paper ran as follows: "The particulars and illustrations given seem sufficient to indicate that ferro-concrete has to be taken into account as a shipbuilding material, owing to its small initial cost and the absence of upkeep. The author is far from thinking that super-dreadnoughts are likely to be built in ferro-concrete, at any rate for the present; but in smaller and commercial craft and for special purposes he is convinced that it will be used more and more. The question of weight is not so paramount as it may seem at first when to the weight of the hull is added that of all fittings and cargo, which remain the same, both for ferro-concrete and for steel ships." The recent strides made in this mode of construction seem to justify those prognostics.

So much has been written lately on the general principles and history of ferro-concrete as applied to shipbuilding that it seems unnecessary to recite once more these facts, and it is proposed therefore to enter at once into more precise details.

I.—Material of Construction

This is evidently a fundamental question, and we shall consider in turn the two components of a ferro-concrete hull, viz., concrete and steel.

(*a*) The concrete employed must be non-porous, so as to prevent leaking and the steel being attacked by sea water; it must also be strong so as to resist the heavy compressive stresses to which, in parts, it is submitted, and it should be as light as possible. The last-named condition is unfortunately difficult to fulfill at the same time as the other two, and the latter are of greater importance. Light aggregates such as pumice stone, ashes, coke, breeze, which are used in land work for making light concrete, are too porous; they would absorb a large weight of water and would give too weak a concrete; they cannot be utilized for ships. Clean shingle, of a flinty nature, is a suitable material, and would give a concrete slightly lighter in weight than crushed granite or whinstone. Gravel originating from sandstone must be subject to careful scrutiny before being allowed for ship construction, as it is sometimes of a somewhat porous and friable nature and might prove a source of weakness both as regards porosity and crushing strength. Crushed granite, and, generally speaking, crushed stone of a hard and impervious nature, are perhaps to be given the preference, notwithstanding their somewhat heavier weight. The same physical qualities are essential for the sand. Of the cement itself, little need be said; years of experience have proved that if it is up to British Standard Specification it will prove suitable for sea work.

With such constituents and it being understood that fresh water only should be used both for making the concrete and washing the aggregate if necessary, a suitable concrete will be made if proper proportions are adopted and the materials are properly mixed. In determining proportions great care should be taken that the aggregate be properly graded, that is, it should contain stones of various sizes, the smaller ones helping to fill the voids between the larger, and the same applies to the sand, which should be a mixture of sharp particles and of finer sand going down almost to dust. The proportions of voids both in the aggregate and in the sand should be carefully determined, and there should be a good excess of cement paste over the quantity strictly required to fill the voids of the sand, and similarly a good excess of mortar (*i. e.*, sand and cement paste) over that required to fill the voids in the aggregate. As previously mentioned, crushed stone will be used often as an aggregate, and it so happens that it contains, as a rule, a considerably greater proportion of voids than shingle, and this may result in porousness in the concrete unless proper attention is paid. The question of voids and of porousness is of very great importance, but forms in itself a vast subject. The author had the opportunity of reading a paper quite recently before the Society of Engineers on this subject, to which he would refer those interested; but it appears to him that its importance is such that it should be particularly emphasized to-night when dealing with concrete for ship construction.

From practical considerations the author does not deem it advisable to allow for a lesser thickness of concrete than 3 inches for the sides and bottom of a vessel, except in special circumstances, and however much one might like to see it reduced so as to lighten the structure. The figure of 2.8 inches is mentioned as a minimum in the preliminary rules for ferro-concrete ships issued by the Danish Government, but except for very small craft 3 inches will prove in practice to be the minimum. The scantlings of frames, strings, etc., are also reduced as much as possible owing to the same desire to reduce the weight, and the thickness may be taken at 2½ inches and even less in some cases, but great care will have to be exercised to insure proper covering of the bars by the concrete and and proper bond between them. It is, therefore, necessary to use an aggregate of small size, which will be worked easily in so restricted a space and among a comparatively great number of steel rods. Some engineers went as far as to suggest the total abandonment of aggregate, and the replacement of concrete by a mere sand and cement mortar. But the method has been proved to be unsatisfactory in ordinary ferro-concrete work, and the same would apply to ship construction. A happy medium is to be recommended, and the author's firm have ultimately adopted the following mixture for their designs:

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†Councillor of the French Board of Trade.

Aggregate, being a well-graded mixture of stones from 5/8 inch size down to 1/4 inch, and free from sand, 27 cubic feet. Sand, from 1/8 inch downward, the grains being also of well-graded sizes, 13½ cubic feet. Cement, 8½ cwt. Such a concrete may be termed a 1.6:2:4 concrete. The above proportions apply as long as the percentage of voids in the aggregate does not exceed 50 percent. If it exceeds 50 percent a corresponding quantity of sand and cement is added. It has been suggested by various engineers that a much poorer concrete might be used with safety, say a 1:2:4 or 1.2:2:4 concrete, if a good rich rendering were applied later on the external surface of the sides and bottoms. But such a rendering would be extremely difficult to make properly, especially when nearing the bow and stern, and with the hard wear and tear to which ships are submitted it would soon come away in patches.

In order to obviate the difficulty of making a proper rendering, other engineers have suggested to use a comparatively poor concrete, say 1:2:4 or 1.2:2:4 for the inner 2 inches or 3 inches of the walls and bottom and to place carefully at the same time in the mold a rich mortar (1 of cement and 1 of sand) to form the external inch. The author's experience leads him to deprecate the juxtaposition of two concretes of so different a richness in cement, and unless supervision of the most constant and strict nature is exercised during the erection he doubts the efficacy of the method. All told, it seems decidedly better to adopt a uniformly rich mixture, such as mentioned above, which will give a very good face to the concrete when the molds are struck off, prove quite impervious, afford a high crushing strength, and be easily worked into the molds.

Steel

We turn now to the other component element of the structure, viz., the steel. The general tendency in ferro-concrete practice has been to utilize as reinforcing material mild steel in the form of ordinary round bars, with an ultimate tensile strength of from 28 tons to 32 tons per square inch, an elastic limit varying from 30,000 pounds to 40,000 pounds per square inch, and an elongation of at least 20 percent on a length of eight times the diameter. Such steel was used in the construction of most of the numerous river and canal barges and pontoons built in ferro-concrete during the last fifteen years, and it was natural to look to the same material again, when great impetus was given lately to the construction of sea craft in ferro-concrete by the difficulty of procuring all the steel plates required for commercial craft. Mild steel was therefore used and will be used in many ships notwithstanding the difficulty one meets in obtaining it at present. Shell discard steel has been put forward as a substitute, mostly with the object of avoiding the use of mild steel, seeing that it is more easily obtainable than the latter at present, but not owing to its special physical properties. For the present, apparently, Lloyd's Register are not prepared to sanction its use. One of their surveyors, Mr. Bernard J. Ives, has stated that, "As the ferro-concrete ship is only in its experimental stage and as practically no experience has been obtained so far from actual seagoing conditions, a wise precaution at the present time is to eliminate any doubtful factors, and the steel should therefore be of the quality used in ordinary shipbuilding work."

It is a question, however, whether the disadvantages attaching to the use of shell discard steel, if one looks at the question from the usual standpoint of steel ship construction, would not be more than compensated by certain advantages it would present from a ferro-concrete point of view. These advantages are somewhat similar to those attaching to the use of a special quality of steel, which the author's firm, after careful consideration of the matter during the last two years, are now specifying for ferro-concrete ship construction. It may be stated at the outset that the problems of ferro-concrete construction as applied to naval architecture are very different from its problems as applied to land work. Firstly, and for obvious reasons, it is desirable to reduce the weight of the hull, and consequently of all the scantlings as much as ever possible, consistent with good work. It becomes, therefore, of great interest to use for the reinforcement steel possessing a higher elastic limit than mild steel, the elastic limit being an all-important factor in ferro-concrete work. Not only does this obviously tend to reduce the weight of steel required, and consequently the weight of the hull, but also the same cover of concrete over the reinforcing rods can be maintained while reducing the thickness of the members by the same amount as the diameters of the high elastic limit steel rods are smaller than those of the mild steel bars which would otherwise be used, thus securing an indirect but very important saving in the weight of the hull.

A second point which deserves very careful consideration is that of the transmission of the stresses in the steel from bar to bar. As is well known, in ferro-concrete construction the bars are not tied together, nor welded, nor connected by coupling boxes (except in very special circumstances). Stresses are transmitted from bar to bar through the agency of the adhesion grip of the concrete surrounding them, the bars overlapping each other. Their ends are usually fishtailed or hooked, with a view to helping further the adhesion. In ordinary ferro-concrete work the mass of concrete surrounding the rods is comparatively large, and there is ample room for overlapping of the rods and for the hooks or fishtails, so that most of the experts in ferro-concrete consider it quite unnecessary to use bars with mechanical bond. In ship construction, as has been previously stated, scantlings are reduced to a minimum, and the bars being very much closer together real difficulty is experienced in finding room for overlaps of the length required if ordinary round rods are used, and also for hooks, especially in longitudinal members. The problem is serious, and experiments carried out in France last year upon a river barge of 400 tons deadweight, which was purposely tested until rupture under load in dry dock, proved the ultimate failure to be due to the slipping of the longitudinal rods, consequent upon the insufficiency of overlapping. It must be added that the overlaps were in fact considerably shorter than sound design would have required. But the indication given must not be neglected. It therefore becomes useful for ferro-concrete ship construction to adopt bars which present a greater adhesive power than ordinary round bars. Tests have proved that certain bars are obtainable which have a grip of 60 percent greater than that of ordinary rounds; their use will obviously reduce the amount of overlapping otherwise required. But such greater adhesion should not be obtained by the addition of sharp projections or ribs on the bars which might have a tendency to be the starting point of minute cracks in the concrete, and which, in addition, are useless from the point of view of the main stresses. In other words, the bond should be continuous, and should not entail an additional weight of steel. To sum up the question of the steel, the author has found the nearest approach of what he considers the ideal steel reinforcement for shipbuilding work in bars manufactured

from mild steel in accordance with British Standard Specification for structural steel, but which, owing to their special shape and the physical treatment they receive after rolling, acquire an elastic limit of over 50,000 pounds per square inch, present a satisfactory and continuous bond without sharp indentations or projections, and remain capable of cold bending round a bar of 1½ times their diameter without injury.

Shell discard steel, if of a somewhat unequal quality, possesses at least one of the desiderata, viz., high elastic limit. Dangerous as may be its use in the shape of girders or, more generally, structural steelwork, where stresses may be said to be extremely localized, it is felt that its use in the shape of numerous rods of small diameter scattered throughout the mass of a ferro-concrete structure does not present the same danger. It seems, therefore, that the question of its employment might be left open for further consideration, and the experience gained from the behavior of the numerous ferro-concrete works in which it was used since 1915 will be of great help in that direction.

II.—Systems of Construction

Having examined the constituting materials, one may now attempt to reply to the query: "What are the various systems of construction?" They seem to fall under two headings—Plastered ships; molded ships.

Plastered Ships

The first cost of a mold in which to cast a ferro-concrete ship, in a similar way as is generally done for ordinary ferro-concrete work, is high, and it was natural that one should attempt to avoid using one. Many of the numerous river barges and pontoons built in Italy since 1902 consisted mostly of a steel mesh work set to shape and plastered on both sides with cement mortar, very much as a ceiling of a room plastered on a metallic lathing. Italians are very clever cement plasterers, and the method proved successful for small craft which are never strained heavily. Small motor boats or canoes have been built similarly in various countries, including of course, the small pioneer rowing boat built in France in 1849 by Lamjot, and which has now become historical.

When one comes, however, to heavier craft, and particularly seagoing craft, mesh work is found to be not practical for the arrangement of the main steel reinforcement; the number of skilled plasterers able to do justice to such difficult work is very small at present; and what is more important, plaster work of that kind does not give a concrete sufficiently strong to meet the stresses imposed upon it. The claims of the "cement gun" in that respect do not appear as yet to be justified. The author is convinced that for all vessels of large size the plastering method has to give way to the method of molding and casting, and he is under the impression that it will not be sanctioned by at least one of the Registry Societies, in view of experience lately acquired in that direction.

Molded Ships

(1) In the first place, there should be a warning against the practice recommended by one or two American contractors of building a sort of rigid metallic work—lattice girders forming the skeleton of all the frames, and also the skeleton of the sides, and encasing this metallic framework in concrete. The advantages claimed are simplicity and quickness of construction. It must be stated that analogous practice prevailed among a few designers in the early days of reinforced concrete construction, but it was gradually discarded in favor of the more scientific and efficient designs which have been in universal use for the last twenty years, the principle of which is that the reinforcement is not a rigid frame by itself.

The author considers that there would be no appreciable saving in time, and there are very serious defects inherent to the system. All ferro-concrete experts agree that the ideal design in ferro-concrete is that in which the reinforcing rods are individually as small as possible and as numerous as is practicable, so that the stresses be distributed to the extreme possible limit throughout the mass of ferro-concrete. The result is best attained by the use of small rods and links. It has been very properly stated by the most eminent authorities on ferro-concrete that it is a new material and not a mere juxtaposition of concrete and steel; it has, in fact, qualities and idiosyncrasies of its own quite distinct from those of its constituent elements. If, however, the steel is concentrated in parts of the mass instead of being distributed throughout, the work thus obtained loses those peculiarities just referred to; the concrete will not lend its properties to the steel and borrow some from the latter in so complete a manner, and *vice versa*. In particular, the large cracks so characteristic of ordinary concrete work, and unknown in ferro-concrete, would tend to appear, and this would be a very serious defect in ships. The work would also lose the resilience and elasticity which is so striking a character of ferro-concrete.

Another point is that a rigid framework of that kind, instead of being made of round bars, would require flat bars and small angles; in fact, structural steelwork of the very kind that is most in demand to-day. It would also require the employment of steel workers of the very kind one wishes at the present time not to draw upon, seeing that all the steel work would have to be punched, bolted and riveted. Moreover, experience has shown that such a method of reinforcement is more wasteful in steel by 15 percent to 20 percent. It has also been found in practice that in reinforced concrete work it is most advisable to avoid any sharp angles or corners in the steelwork, all such angles being potential starting points of cracks; and that concrete adheres less easily to comparatively large and flat surfaces such as presented by angle bars than to ordinary round bars. It may also be added that if, in order to avoid riveting, an attempt is made to use bolts, as the bolt holes will be greater diameter than the holes (so as to facilitate fitting up) there will remain throughout the framework an immense number of small recesses to which concrete will not have access; the steel work will therefore not receive in those points the protection against corrosion which the concrete should afford it, and such points will be potential starting points of corrosion. For all those reasons, tempting as the idea may be at first to those not thoroughly accustomed to reinforced concrete work, rigid framing has to give way to the usual non-rigid round bar skeleton reinforcement.

(2) The Norwegian method of casting the boats upside down, launching them in that position, and letting the hull right itself in the water, has been profusely described and illustrated in the daily papers and magazines. The reason for that unusual procedure is stated to be a desire to avoid the use of double shuttering. But, as far as the deck and bottom are concerned, there is no more need for a double shuttering in the usual method than in the upside-down one, and as regards the sides there is as much need for it in one as in the other. It seems that the upside-down method has been used for very small vessels, 200 tons deadweight, but it is doubtful whether it is workable in the case of bigger craft, say 1,000-ton or 2,000-ton boats, and the author is at a loss to see any advantages in it.

(3) In the construction of river barges in France, the desire to reduce the cost of shuttering has led to certain constructors experimenting with pre-cast wall plates of the required dimensions to fill the rectangular spaces between frames and stringers. The frames and stringers are cast *in situ*, and the wall plates set in position between them so as to be incorporated into the structure during their concreting, the bond being given by the ends of the reinforcing bars of the plates, which protrude all round. Although the results were said to be satisfactory (at first in any case) it is interesting to note that when the same contractors built larger river craft (600 tons and 1,000 tons deadweight) they abandoned the slab principle and reverted to casting *in situ*. For seagoing craft, which are submitted to hogging and sagging stresses, the author feels that the slabs would work loose, and further, the steel used in their construction, and which is in short lengths, would not be utilized for meeting the general stresses in such an efficient manner as it can be when the plates are monolithic with the frames and stringers. This mode of construction is therefore to be deprecated.

(4) Another "system" is that in which timber molds are dispensed with for the walls by using two sheets of metal lathing between which the concrete is poured. Some of it works through the mesh and forms knobs upon the two outer surfaces, which knobs in turn form anchorage for plastering coats added later on. The objection against the use of plastering coats required to finish the surface has been stated before. Another drawback of this method is the concrete poured between two resilient sheets of meshing cannot be rammed or punned properly, and, in consequence, it is impossible to obtain a good, strong and impervious concrete. The advocates of this method, in fact, are said to recommend the addition of a waterproof coating, which the author has no doubt would indeed prove very necessary with such a method.

(5) Reverting now to the normal and usual method of construction, it can hardly be divided into systems. A few patents have been taken in the matter, but they mostly bear on questions of detail; the general principles underlying all the designs are the same, and it is merely the experience and skill of the designers which may differentiate the various types adopted. In that respect the author is fully in accord with the remarks made by Mr. A. T. Wall in the *Engineering Supplement* of *The Times* regarding the absolute necessity for close cooperation in the design of ships between naval architects and ferro-concrete experts. The latter, or at any rate the broad-minded ones among them, fully recognize that the science of naval architecture and the practical experience which is necessary when applying its principles, require years to be acquired; and in the same way the extremely complex problems of ferro-concrete design as applied to naval architecture can only be solved by the application of years of experience. Excellent results will be the fruit of close co-operation, and the attempt to work independently of each other has already resulted in a number of failures, and will continue to do so.

Having thus reviewed the material and the method of construction of ferro-concrete ships, it is now necessary to inquire into the claims put forward by the advocates of such ships, and see whether they can be substantiated.

Speed of Construction

One of these claims is a great speed of construction. It must be borne in mind that up to the time of writing the biggest units launched are barges of 1,000 tons deadweight. For bigger tonnage no actual facts can be mentioned, but by inference experts may gage pretty accurately the time required.

In the construction of a large number of 250 horsepower tugs now being built in France, the author was able to satisfy himself that two weeks were sufficient to erect the molds (for repeat tugs; the erection of the first mold took somewhat longer) and place the steel in position. The process of concreting was occasionally carried out in 48 hours. All told, it is safe to say that in normal working the yard referred to completes a hull in three weeks. The tugs take water broadside on, and an average of three weeks is allowed for maturing. With the restricted amount of labor at present available, the said yard can turn out one of these tugs every week, but from explanations given to the author by the yard's manager it is certain that two tugs could be completed every week in normal times.

In another place the author has seen in what was four months before a bare field, two 1,000 ton deadweight barges ready for launching, and several others following closely. Barges of that kind, or again, the hulls of small cargo steamers of 1,000 tons deadweight, may easily be turned out and launched at the rate of one every ten weeks from each slip in a well-organized yard. For obvious reasons it is impossible at the present time to give precise figures as to the actual speed of construction of bigger ferro-concrete craft. However, having discussed the programmes of construction both with British and with French contractors, the author considers that in regular working order the completion of the hull of 1,000 tons deadweight cargoes would take about 1½ months from start to finish. That of 2,000 tons 2 months. A 3,000 tons cargo would require 2¾ months, and a 5,000 tons about 4½ months.

The time required for the fitting of machinery, etc., would be practically identical for such ships and for steel ships, so that from the above figures the total time required to complete the ship may be deduced. It will be understood that from 3 to 5 weeks has to be added to allow for the maturing of the concrete. In ordinary land work one considers generally that a test load may be imposed upon a new floor 5 or 6 weeks after its completion. But the concrete used in that case is not so rich in cement as for ships, and the richer the concrete the quicker the required strength is attained. It might be possible to utilize that period for partly fitting up the ship instead of waiting until she is afloat, so that the maturing period would not be lost altogether.

Ease and Speed of Repairs

This question of speed in construction leads us to another important consideration, viz., the ease and speed with which ferro-concrete ships may be repaired. Ferro-concrete has been proved to withstand damage to a remarkable extent. One need only refer briefly to its excellent behavior during the earthquakes, during subsidence of foundations, etc. This is due to the monolithic character of the work and its great cohesion.

The following example will give a clear idea of the possibilities of ferro-concrete in that respect. In 1909, a monolithic building was erected from Messrs. Mouchel & Partners' designs at Northwich, a district famous for appalling subsidences due to the extraction of brine from the lower strata. The building, boxlike fashion, rested on 20 foundation piers, but without connection with them, and it was arranged that the piers should be kept under observation, so that if any showed signs of subsidence packing should be inserted and the building jacked up. In December, 1915, signs of subsidence were detected, and a joint inspection was made by the Surveyor of the Northwich Salt Compensation Board and the author, when the almost incredible fact was revealed

that out of the 20 piers 12 had subsided and parted with the superstructure, the latter remaining supported on eight piers only. Enormous strains must have developed in the portions of the building thus transformed into big cantilevers, but the report stated that "thorough inspection of the whole building, with special attention to mainbeams, secondary beams and ceilings failed to reveal any trace of weakness or strain." Such is the resiliency, the power of accommodation to new circumstances, of ferro-concrete.

Again, in 1907 an 8,000-ton steamer crashed into a ferro-concrete jetty in the river Thames. The engineer, Mr. C. S. Meik, M. Inst. C. E., stated at the time that if the jetty had been a timber one the steamer must have gone right through it. As it was, the only damage was the destruction of a few piles and about 20 square feet of decking.

It must be understood that damage to ferro-concrete work is always of a most localized nature. At the time of the great explosion at Silvertown in January, 1917, a steel girder weighing nearly one ton was blown up and fell headlong upon a ferro-concrete wharf some 50 yards away. It went through a panel of the decking, but the hole made was hardly more than 1 foot by 2 feet, the adjoining beams not suffering in the slightest; the damage was therefore insignificant and most easily repaired.

This localization of damage, which is extremely important in ship construction, is borne out by observation of the effects of shell fire on ferro-concrete. On the western front a ferro-concrete water tower 52 feet high formed for a long time a convenient observation post for the Germans and a prominent target for our guns. When in March, 1917, the Germans proceeded with their so-called "victorious retirement," they took good care to bring down the tower by dynamiting its legs, the tank proper falling from its full height to the ground. But according to written statements, the shells which had struck the tank merely made circular holes through the sides and bottom, and the fall to the ground caused only local cracks. After small repairs, the tank could be used either on the ground or jacked up gradually to its original position.

Such local damage as may occur in ferro-concrete ships will be most easily repaired, the hole being blocked up by providing a small timber shuttering and filling the hole with new concrete, after having added, if need be a few strengthening bars. By using a very rich mixture of concrete, the patch will be able to stand the water pressure in a couple of days or even less, and if need be, one may not remove the shuttering before putting to sea again, for further safety. Such a repair may even be carried out under water. Cementing or concreting repairs to quay walls or jetties under water are by no means processes unknown to civil engineers.

In December last the author had the good fortune (if he may put it that way) to inspect a 1,000-ton barge which a couple of days previously had suffered damage during a faulty launching; it had been repaired as explained above, and was then afloat and in excellent condition. Several instances of damage to river or canal barges in use abroad have been recorded, pointing all to the same conclusion, and all investigators seem agreed that repairs to ferro-concrete ships will be quicker and much cheaper than to steel vessels. Alterations to the design in course of erection, or while the ship is in service, are quite easy. The author has witnessed in France a fairly sweeping alteration in the position and arrangement of hatchways and companions in a vessel nearing completion, which confirms this statement.

Lasting Qualities of Ferro-Concrete Vessels

Views on that aspect of the question are difficult to express, for the reason that experience has not yet been obtained regarding their behavior at sea over long periods. Most probably steel shipbuilders found themselves in the same predicament when steel was first put forward as a substitute for timber. Let us also proceed by inference. We know that ferro-concrete on land is a most permanent material, requiring no upkeep, no painting, and increasing in strength with age. We know that the same applies to ferro-concrete seat work or tidal work, jetties, quays, etc., when properly designed and carried out. There may have been a few cases (very few indeed in proportion to the number of successful works) in which defects developed. But in those cases the defect can always be traced to causes which do not affect the principle of ferro-concrete, and could have been avoided by taking due care. The author has read practically every attack made upon ferro-concrete and its lasting properties, but up to the present he has not seen one that was vital. Local examples being always of special interest, one may properly refer here to a ferro-concrete jetty built in 1901 at the C. W. S. works, Dunston-on-Tyne, with a rise and fall of tide of 15 feet, and which is in absolutely perfect condition, although it is now submitted to much greater shocks than was anticipated owing to the increased tonnage of vessels accommodated.

We know, further, that ferro-concrete vessels for river or canal or harbor work have stood the test of time very well indeed; comprehensive lists of such vessels have been printed so often lately that it is unnecessary to repeat them.

On the other hand, we know that seacraft are submitted to much more severe strains, and this is where doubt may arise. To overcome the difficulties which confront ferro-concrete seacraft, one must first of all realize them fully, and recognize the inherent drawbacks of the material. It is then comparatively easy to devise means for removing the disabilities. That there will be failures cannot be doubted. Most of them will arise from imperfect understanding of the effect of combined stresses. But the experience already at our disposal is sufficient to show that some of the difficulties encountered can be overcome by more careful designing, and there are good grounds for assuming that the ferro-concrete vessels which it is now proposed to build up to a certain size will have the necessary lasting qualities. The question now arises as to what is the limiting size of ferro-concrete ships, but before trying to give a tentative reply to the query it is necessary to face one of the great defects of ferro-concrete vessels, viz., their weight.

Weight of Ferro-Concrete Vessels

It is so obvious that ferro-concrete vessels are heavier than steel ones that there is no need to explain why. The important point is to make a comparison between vessels of the two classes and of same deadweight carrying capacity. The designs of vessels upwards of 1,000 tons deadweight prepared by the author's firm comprise one deck single-screw cargo vessels of 1,000 tons, 2,000 tons, 4,000 tons and 6,000 tons deadweight, and the comparison will be limited to those. It must be stated that the full detailed working plans for the larger units are not quite completed as yet, so that slight alterations in the figures here below given are possible.

In the following tables the figures referring to the steel vessels have been kindly prepared by Mr. R. Cole and Mr. H. Burgess, of Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, also the design of the

ferro-concrete vessels has been prepared in collaboration with Mr. T. G. Owens Thurston, of Messrs. Vickers, Limited and to them the author wishes to tender here his best thanks.

The annexed Table I allows one to compare at a glance the main characteristics of the vessels. From the figures in that table another, Table II, has been prepared, which gives the factor for converting deadweight carrying capacity into total displacement, both for the steel and the ferro-concrete vessels figuring in Table I.

One can see that the disadvantages attaching to ferro-concrete vessels in the matter of weight are greater in the case of small tonnage; although ferro-concrete vessels cannot hope to become as light as steel vessels even for big tonnage, the disadvantage becomes less and less marked when the size grows. This is due to the fact that the minimum thickness of concrete which is necessary for practical reasons, even for small units, need not be increased at the same rate when tonnage grows bigger. Where 3 inches are necessary for a 1,000 tons cargo, a 2,000 tons requires hardly 4 inches.

TABLE I.—ONE-DECK, SINGLE-SCREW CARGO STEAMERS

Deadweight All Told in Tons.	1,000		2,000		4,000		6,000	
	Steel.	Ferro-Concrete.	Steel.	Ferro-Concrete.	Steel.	Ferro-Concrete.	Steel.	Ferro-Concrete.
	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.
Length between perpendiculars	180 0	210 0	220 0	245 0	285 0	305 0	340 0	355 0
Breadth molded	29 0	33 6	35 0	38 9	41 6	44 3	45 9	48 0
Depth molded to upper deck	16 6	16 9	20 0	20 3	25 0	25 3	28 3	28 6
Mean draft	14 9	14 9	17 9	17 9	21 3	21 3	23 3	23 3
Displacement in tons	1,600	2,225	2,910	3,660	5,550	6,465	8,240	9,210

TABLE II.—FACTORS FOR CONVERSION OF DEADWEIGHT CARRYING CAPACITY INTO TOTAL DISPLACEMENT

Deadweight All Told in Tons.	1,000	2,000	4,000	6,000
Steel vessels	1.600	1.455	1.387	1.373
Ferro-concrete vessels	2.225	1.830	1.616	1.535

TABLE III.—EXCESS DISPLACEMENT OF FERRO-CONCRETE VESSELS OVER STEEL VESSELS OF SAME DEADWEIGHT CARRYING CAPACITY

Deadweight All Toldi n Tons.	1,000	2,000	4,000	6,000
Excess percent	39	25.8	16.5	11.8

For a 1,000 ton deadweight steamer the displacement of the ferro-concrete vessel exceeds that of the steel vessel by as much as 39 percent; for 2,000 tons deadweight the excess is only 30 percent; for 4,000-tons deadweight, 18 percent; and for 6,000 tons deadweight under 15 percent. It seems probable that for vessels over 6,000 tons the excess may be lowered further still, very slightly, say to 14 percent or 13 percent, but that would seem to be the limit, at any rate, until new developments take place in ferro-concrete naval architecture. But even as the case now stands, one might be tempted to say that the consideration of weight would not place any upward limit to the size to which ferro-concrete vessels may be built. There is, however, another important consideration which comes into play, viz., that of comparative cost, which has now to be inquired into.

Cost of Ferro-Concrete Ships

The saving which can be effected by ferro-concrete in a certain class of vessel is due partly to the saving in steel, partly to the fact that no heavy plant is required for ferro-concrete work, and partly to the fact that the bulk of the labor employed need not be skilled, and is therefore cheaper. But if the last two factors remain the same whatever the size of the vessel, the first is a variable one. To start with it must be stated that the saving in steel is not as great as was wildly claimed at first by superficial designers who had not grasped the difficulties of the problem; a saving of 80 percent, or even more, as has been mentioned occasionally, seems quite out of the question. Nevertheless the saving exists, and in some cases exceeds 50 percent, or 55 percent, which is not at all negligible. And in that respect it is as well when comparing figures to note that in ferro-concrete there is no waste of steel in the process of construction, whereas it seems a recognized fact the weight of steel required for building a steel ship is about 10 percent greater than that of the steel which is finally embodied in the structure owing to waste in cuts of plates, angles, rivet holes, etc. As far as stresses go steel is not used very economically for steel ships of small tonnage, but it receives a better utilization when the tonnage grows. By way of illustration, taking as units the stresses per square inch on the upper deck and on the bottom plating respectively for steel cargo vessels of 1,000 tons deadweight, it may be assumed that the stresses in bigger vessels would approximately be greater in the ratio shown in the following Table IV:

TABLE IV.—RATIO OF INCREASE OF STRESS TONS PER SQUARE INCH

Deadweight in Tons.	1,000	2,000	3,000	4,000	5,000	6,000
On upper deck	1	1.18	1.33	1.44	1.54	1.64
Bottom plating	1	1.22	1.40	1.58	1.75	1.94

It will be seen that steel vessels have to meet the same difficulty as ferro-concrete vessels in the case of small tonnage, viz., a bad utilization of the full strength of the constituent materials. Whereas, however, in the case of ferro-concrete it is the concrete which is badly utilized (as far as its potential strength is concerned), in steel vessels it is the steel. In both cases the drawback gradually disappears when the tonnage increases.

A much better utilization of the steel takes place in ferro-concrete ships of small tonnage, utilization which cannot be improved upon very much when tonnage increases. It would seem that the important saving in steel resulting from the adoption of ferro-concrete for ships of small tonnage remains a fairly constant percentage up to, say, 3,000 tons deadweight, but in the light of present designing that for larger units it would become gradually smaller.

It is most difficult to give an accurate comparison of the prices for steel and ferro-concrete ships. The question is so beclouded by considerations of many kinds that it has been questioned whether the undeniable advantage which ferro-concrete offers to-day in this respect will remain when normal times return. The author feels unable to give precise indications which actual experience may alone procure. But it seems fair to say that on a pre-war basis one may estimate that the cost of the ferro-concrete hull is about 70 percent of the cost of the steel hull of same deadweight carrying capacity in the case of small tonnage, the saving becoming somewhat less important for bigger units. As against this one may set up the fact that the cost of machinery and outfit for concrete vessels is, approximately, 5 percent dearer than it is for steel vessels.

In conclusion, the author wishes to apologize for the limitations of the paper and its shortcomings, of which none is more aware than himself.

A System for the Design of Ships with Straight-Lined Sections

Simplicity of Calculations, Laying Off and Construction the Key-note of New Method Proposed for Designing Straight Line Ships

BY C. W. BION

THE writer would like to pass a few general remarks on ship forms and their relations to resistance, especially as the system to be described is largely dependent on them.

The two curves which govern the form of any vessel are the curves of transverse sectional areas and the load water plane. Sir Phillip Watts once said that the principal feature which governs the resistance of a ship is the longitudinal disposition of its volume. Once, therefore, having fixed the areas curve, the next important factor which comes into play is the load water plane, for it is obvious that this curve at once governs the vertical distribution of volume. In other words, the load waterline curve, together with the areas curve, will give the coefficient of fineness of each transverse section in the ship—i. e., the vertical disposition of volume.

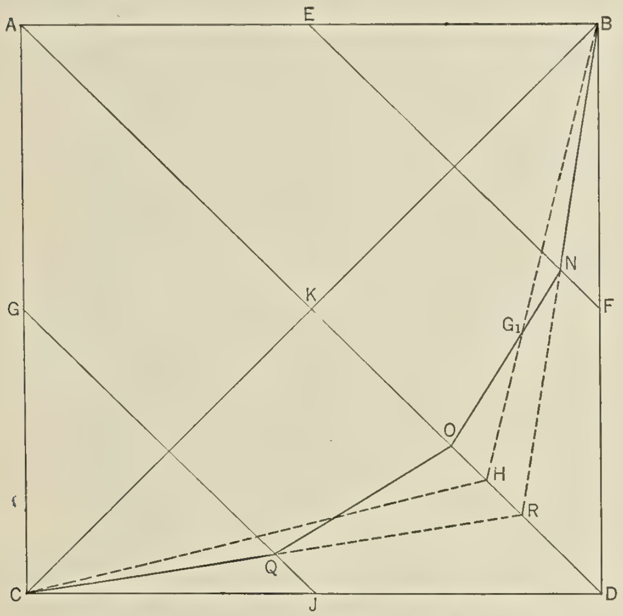


Fig. 1.—Construction for Transverse Section

In passing, it may be remarked that the shape of the curve of coefficients of fineness of sections, especially that of the after body, is of some importance and interest with regard to resistance, especially at high speeds. Admiral Taylor has conducted experiments bearing on the above point.

Passing now to the shape of the transverse sections of ships, which is really the subject of this article, it will be conceded that they are generally of parabolic form. Admiral Taylor has shown them to be parabolic for fine coefficients and hyperbolic for full coefficients. The writer has made some investigations in this matter and finds that they can be represented by parabolas described generally by the figure used in connection with Morrish's formula for the vertical position of the center of buoyancy. Sections which are wholly convex or concave outward give the best results, especially in the full size ship, as they insure the easiest motion in a sea way. Very concave convex sections aft are rather liable to cause thumping action at sea and therefore reduction of efficiency. Thus in the series given below a section aft of .500 coefficient is described by a straight line.

To obtain a series of straight-line transverse sections Morrish's figure was taken as a basis and modified as follows. Fig. 1 shows the construction of one of these sections comprised of four straight lines. The point to be

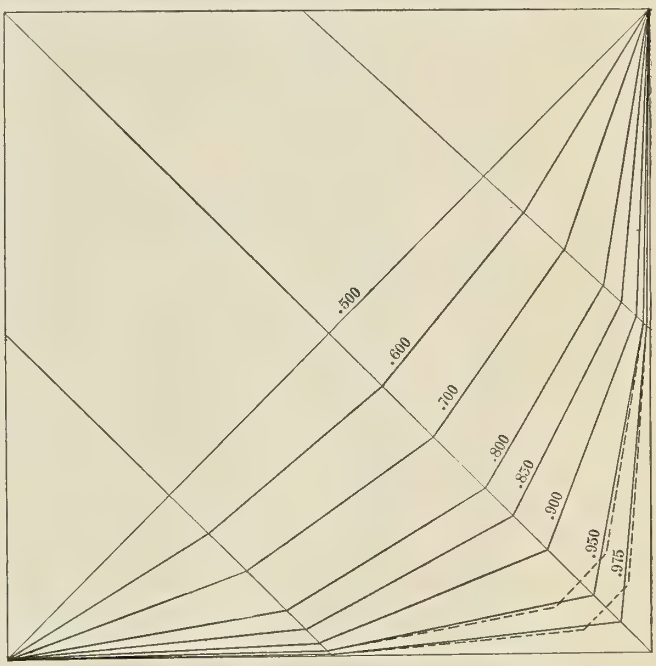


Fig. 2.—Series of Transverse Sections

observed was that these figures must be such that *BR* and *RC*, which may be considered as the tangents at load waterline and keel, must never lie outside the enclosing rectangle. This was obtained by following parabolic forms whose tangents at *B* and *C* always lay within *BD* and *CD*. The point *O* was then found so that *BR* lay within *BD*. To obtain *BR*, set off *HR* equal to *HO* on the diagonal *AD*, *H* being the intersection of the Morrish figure on the diagonal. Now as coefficients increase, *Q* and *R* will converge towards *H;* that is to say, if all such lengths as *KR* were plotted to a base of coefficient of fineness the first differential of this curve would never be zero before *KR* equaled *KD* or when the coefficient of section equaled 1.000.

In the series given, the first differential is zero at the point when *KR* = *KD*. To obtain the points *N* and *Q*, draw *EF* and *GJ* parallel to *AD* and cutting *AB*, *BD* and *AC*, *CD* at half their lengths. The intersections of *BR* and *EF* and *RC* and *GJ* will give the points *N* and *Q*. The figure *ABNOQC* equals *ABHC* in area and approximates to a parabola since *NO* and *OQ* cut *BH* and *CH* at one-third their lengths from *H*. To describe any one of these

DESIGN OF SHIPS WITH STRAIGHT-LINED SECTIONS

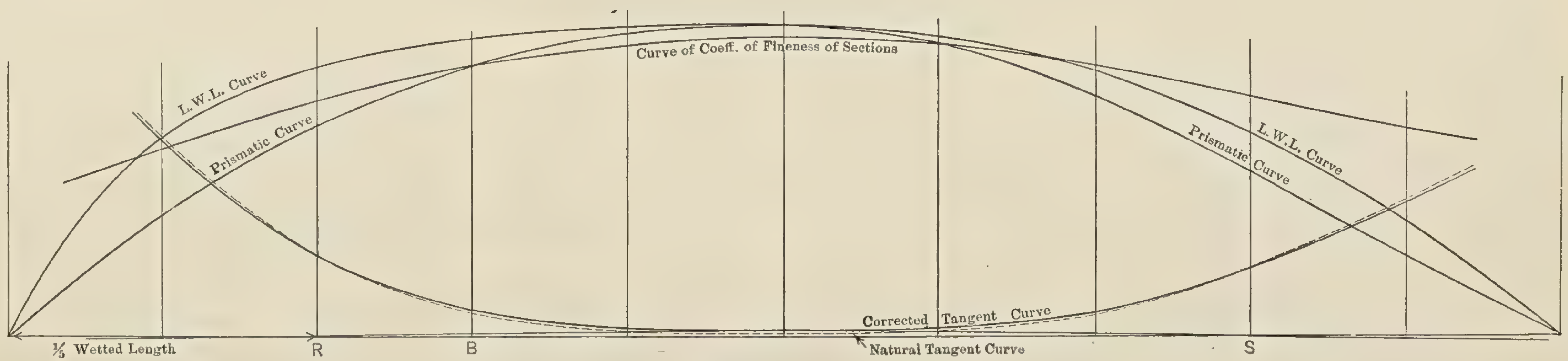


Fig. 3.—Waterline and Area Curves

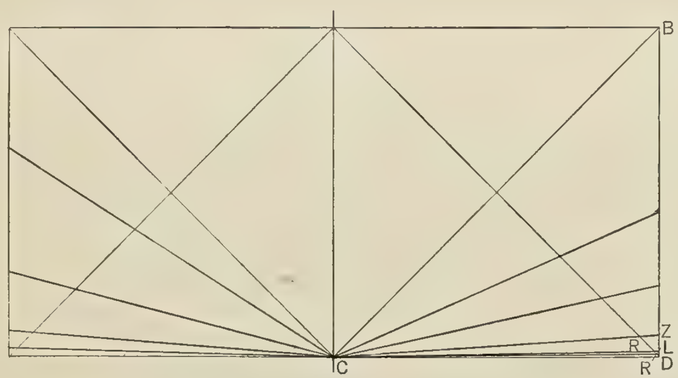


Fig. 4.—Showing Natural Tangents

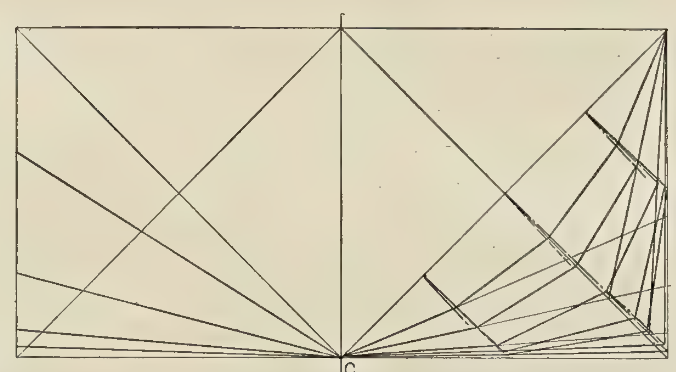


Fig. 5.—Showing Corrected Tangents and Sections in Fore Body

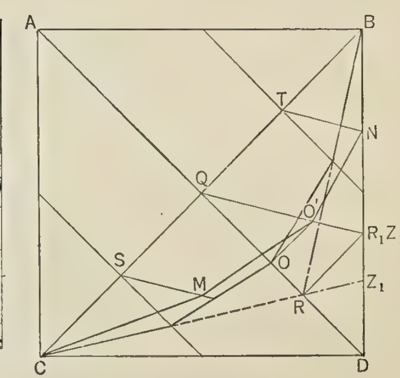


Fig. 6

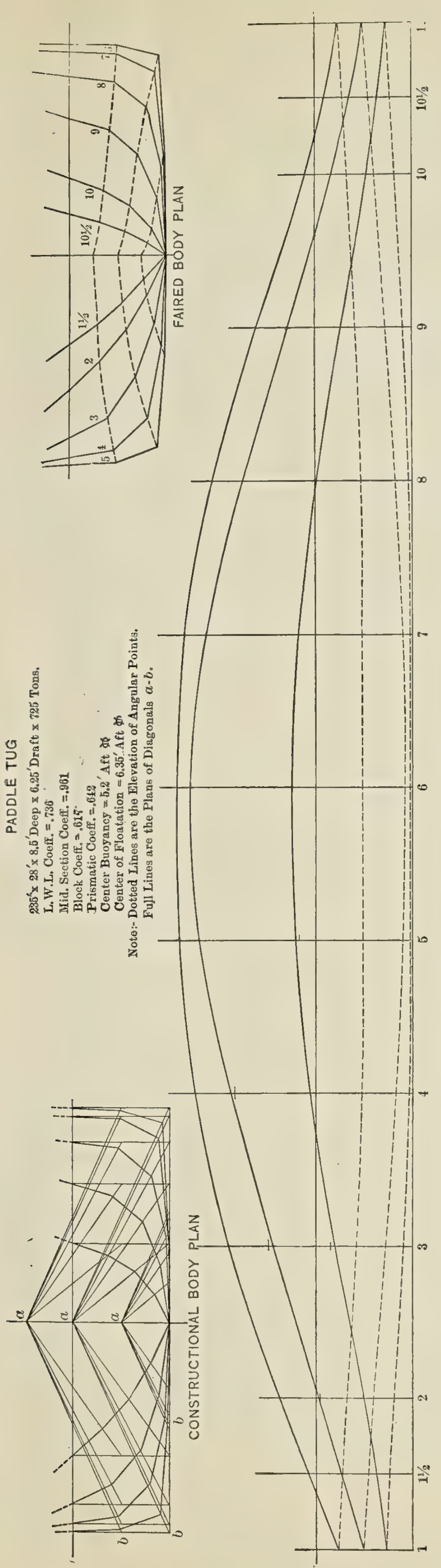


Fig. 7.—Curves Used in Fairing Up Lines of Paddle Tug with Straight-Lined Sections

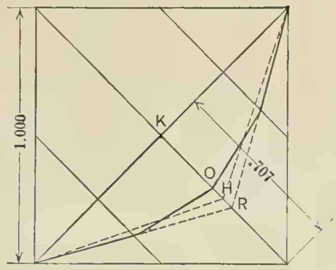


TABLE I

Coefficient of Sections	KO	KH	KR
.500	.000	.000	.000
.550	.058	.071	.084
.600	.116	.142	.168
.650	.173	.213	.253
.700	.231	.284	.337
.750	.288	.354	.420
.800	.346	.425	.504
.850	.404	.495	.586
.900	.480	.566	.652
.950	.582	.637	.692
1.000	.707	.707	.707

figures, it is, therefore, only necessary to know the position of O and R for the particular coefficient desired. Table I gives these lengths for several coefficients from which cross curves on base of coefficient of fineness of section can be drawn. Fig. 2 shows this series of figures up to all coefficients. A slight modification to these sections must be made for structural reasons, when coefficients exceed .900 and this modification is also shown.

The procedure for designing a set of lines is as follows:

1. First draw in the areas curve and load waterline curve on a base of 25 inches, and having unity as the maximum ordinate as shown in Fig. 3. If there is no trim, the coefficient h of any section B is obtained by dividing the areas curve multiplied at B by that of the load water plane and multiplying the result by the coefficient of the middle section. These coefficients are then plotted

TABLE II

Where m = coefficient of maximum section

Number of Station	L.W.P. ordinate multipliers.	Sectional areas curve ordinate multipliers	Mean draft considered unity. Draft multipliers	Coefficient of fineness of section = $\frac{③ \times \mu}{② \times ④}$	Diagonal ordinates from Table I.		Functions of tangents at keel = DZ	Correction to ⑧	Final function of tangent at keel	Function of vertical position and actual position of three angular points from keel			Function of horizontal positions and actual positions of angular points from center line		
					O	R				Q	O	N	Q	O	N
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															

on the same base, the ends running up to unity in the form of asymptotes. It may be noted for a good design the coefficients forward of midships or maximum section are fuller than aft; also the maximum section coefficient should generally be the fullest in the ship.

2. In two squares (Fig. 4) for the fore and aft bodies the points R for the sections are spotted and the lines CR produced to meet BD in Z. All these points Z are then set off on the 25-inch base and a curve run through (they should, of course, be quite fair). It may be mentioned that this Z curve is only the reverse of the coefficients of sectional fineness—i. e., the first differential. Now, if it is desired to have the ship's side parallel at midships, draw RL (for the maximum section) parallel to the diagonal BC of the square (Fig. 4) to meet BD in L. The curve of tangents must now be modified as follows. Sections at one-fifth of the ship's wetted length for the ends must remain unaltered. Therefore, the new curve will take the form shown, the differences between old and new curves being obtained by plotting the height ZL from the base and joining it to R and S shown on 25-inch base (Fig. 3), the ordinates between these two straight lines and base being added to or subtracted from the old curve, according as the straight lines lie above or below the base. Reference should be made to Sir A. Denny's remarks before the Institution of Naval Architects in London on the method employed by his firm on standardization of ship forms for tank purposes.

3. Take two more squares and spot the new tangent intersections obtained from the modification described above and join them to C (Fig. 5). The new positions of O and R are obtained as follows. For each section from its O and R plotted on the diagonal of the square draw lines parallel to the other diagonal as shown in Fig. 6. The point of intersection of RL with the new tangent CZ_1 gives new position of R, called R_1. Join QR_1. Let the line through O parallel to BC cut QR_1 in O'; then O' is the new position of O. Through S and T draw lines SM and TN parallel to QR_1. Join R_1 to B, then $BNO'MCA$ is the section wanted. After having done this for all the sections, reduce these figures to their respective sizes with regard to beam and draft on a body plan. Fig. 7 gives an actual example of a tug. The sides at maximum section were not altered as described above for simplicity sake. Table II gives detail of calculations involved.

4. As a final fair up, plot all ordinates such as a b on the 25-inch length (Fig. 7) and run curves through. If the drawing has been accurate these will be quite fair, any unfairness being corrected in the final body plan, as shown in Fig. 7.

With reference to considerations of construction, each set of angular points can be utilized as longitudinals with widely spaced deep frames, intermediate frames being bracketed to the longitudinals. The exact shape of the side plates can be procured by expansion similar to that for the stern plating round the counter of a merchantman. It is easily seen that the top sides can be suitably worked in, in straight lines, the decks above load line taking the place of longitudinals. The Isherwood type of construction would be especially suitable for these forms. Ferro-concrete ship construction should be much facilitated by the adoption of this type of design.

Summing up, therefore, the advantages to be gained by the adoption of the above system are:

1. All calculations involved in the design are extremely simple.

2. A simplified system of laying off insures the accurate maintenance of the required dimensions and speed in marking out frames, plates, etc.

3. Simplicity of construction especially suitable to ferro-concrete ships.

4. Cheapness because of the small amount of smithing, rolling, etc., required.

5. Adaptability to the longitudinal system of construction.

6. The forms lend themselves to standardization.

7. The angular points follow as closely as possible stream lines, thus reducing resistance.

Four-Masted Schooners Built from Designs of New York Naval Architect

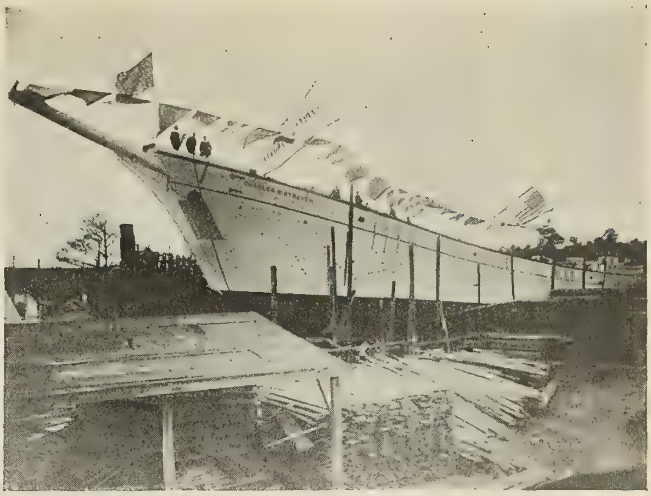
"Ships, ships, and more ships!" is the cry continually heard to-day. Shipbuilding is the most vital industry in the United States, and, incidentally, ships are most essential for the successful prosecution of the war. Henry J. Gielow, one of the foremost naval architects in the country, and senior member of the firm of Gielow & Orr, naval architects, marine engineers and ship and vessel brokers, 52 Broadway, New York City, set about in the early stage of the war to perfect a design of wooden cargo carriers that could be turned out quickly, economically and in large numbers, thereby relieving the tremendous pressure and demand for bottoms. Views of one of a fleet of four-masted schooners just completed in a southern yard from Mr. Gielow's design are shown on page 339. The principal dimensions of the craft are:

Length over all	190 feet 6 inches
Length on waterline	160 feet 10 inches
Beam, molded	36 feet 8 inches
Minimum depth of hold	12 feet 10 inches

The construction throughout embodies the most progressive method used in modern shipbuilding to-day. The keel is of white oak, 14 inches by 14 inches, with scarphs 6 feet long, bolted together. White oak is used for the 12-inch by 29-inch stem and 17-inch sided stern post. The forward deadwood extends up on the stem to meet the apron and runs down on the keel so as to make a good lap. This is bolted through the stem and keel, while the aft deadwood, of white oak, extends down on the rider keelsons and is sided 14 inches. A heavy white oak transom sided 12 inches is bolted to the stern post. White oak frames are used throughout, being 14 inches at the heel and 12 inches at the planksheer. Yellow pine keelsons, three tiers wide and three tiers high, are all scarphed with 6-foot scarphs and thoroughly bolted. Yellow pine, 10 inches by 14 inches is used for deck beams, except hatch beams and partner beams, which are 12 inches by 14 inches molded, 14 inches at the center and 8 inches at the end, spaced four feet on centers, and have hackmatack knees under each end of each beam thoroughly bolted. Three hatches about 14 feet by 18 feet, with yellow pine coaming 24 inches high, and covers of cedar 1⅞-inch dressed, tongued and grooved, are thoroughly ironed on top and inside, and provided with two hatch bars at each hatch to set up with screw bolts. Stanchions are of white oak. Garboards, planking and planksheer are of yellow pine. Decking and stringers are of yellow pine, while the deck beams are of white oak.

The masts are all of selected Oregon pine of the best quality, while the rigging is a special charcoal galvanized wire, all running rigging being pure manila and hemp rope.

A Fairbanks-Morse hoisting engine, belted with drum for hoisting cargo and 6-inch wrecking pump and 3-inch suction pump, is installed.



Views of First of Fleet of Wooden Four-Masted Schooners Building to Designs by Henry J. Gielow, Naval Architect, New York

On her maiden trip the vessel loaded 930 tons of coal at Newport News for Martinique, and made the trip in twenty days, which proves beyond a doubt that she is an exceptionally good sailer. On her return trip she loaded log wood for Philadelphia. Her owners speak very highly of her and state that she loads lumber very easily and can carry 475,000 feet. Her builder stated that he did not believe the lines of the vessel could be bettered in any way, which speaks very highly for her designer. The designer has won world-wide recognition of his ability to design any type of a commercial vessel and obtain the most satisfactory results, which has been proved by the numerous contracts on hand, and already completed, of ferry boats, lighters, tugs, barges and motor ships.

On a Southern trading steamer an oiler used a piece of white mosquito netting about 16 inches square instead of a handful of waste to wipe his face. When hung in a draft it dried almost at once. Great idea, that! Try it.

The man who starts to monkey with the weights of an automatic governor hunts trouble and gets it. Leave them alone.

When cutting rubber, wet your knife—it will make the job easier.

Engineering Education as Applied to Naval Architecture and Marine Engineering*

BY H. A. EVERETT†

THE oldest school for naval instruction and the ranking school in France is the Ecole d'Application du Genie Maritime of Paris, originally established in 1765, but undergoing many changes and removals, finally returning to Paris in 1882 and organizing the present curriculum about then.

The course is a two-year course taken upon the completion of a two-year course at Ecole Polytechnique, the whole corresponding to the four-year course common in engineering colleges here, in which the professional work does not begin till the third year. The ranking men from the course at the Polytechnique have the privilege of selecting the government bureau they wish to be trained for, and naval construction is considered the prize department.

The course throughout lays great stress upon facility in mathematics, and has even been criticised as paying too much attention to this branch. Instruction is given by lectures, drawing-room work and shop work. The daily

* From an address delivered before the Delaware River Branch of the American Society of Marine Draftsmen, February 8.

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routine is a two-hour lecture every morning beginning at 8:30, followed by a question period, with examinations every week. The afternoons are devoted to drawing or shop work. The term is from September 20 to July 1, and the summer period is devoted to inspection trips to navy yards and shops, of which a report and sketches are turned in and are marked as part of the required work. Both summer periods are spent in this, and aside from this very little practical work is attempted.

In Great Britain the Royal Naval College at Greenwich may be considered as the senior school, and, like that just mentioned, educates men primarily for naval constructors. The course as now given was established at Greenwich in 1873, though there has been some instruction given prior to this at South Kensington.

The Royal Naval College at Greenwich

Entrance to the Royal Naval College is via two routes, one by examination, and in practice this is open to all British subjects, and two by selection from the training schools for dock-yard apprentices. As these latter furnish the bulk of the candidates, a brief description may be of interest. They were established by the Admiralty in 1843 under the name of dockyard schools, but very materially revamped in 1905. There are six of them (Chatham, Sheerness, Portsmouth, Devonport, Halbowline, Ire.), and another is soon to be established at Rosyth.

Boys fifteen to sixteen years old become apprentices in the dockyard as a result of a competitive examination held annually, and the apprenticeship covers six years. They are classified into two sections according to their position on the list of successful candidates. The better section (upper school) attend school on two afternoons and three evenings per week for four years. Apprentices who complete this course and show especial merit are recommended for cadetship in naval construction, and if appointed are given a year's course of combined theoretical and practical instruction at one of the large home dockyards before proceeding to the Royal Naval College at Greenwich for a further course extending over two or three years. On completing this, those who obtain first or second class certificates on their final examinations are confirmed in the Corps of Naval Constructors as assistant naval constructors, second class.

At Glasgow University the course in naval architecture was established in 1883. It consists of a three-year course, with the professional work beginning in the second year. Entrance is by examination, and the men are expected to obtain practical work in the yards during the summer recess.

Night Courses in Great Britain

Much of the educational work of a grade just below our college grade is carried in Great Britain by night courses, and some of the major organizations which give excellent evening courses in naval architecture and marine engineering are the Glasgow and West of Scotland Technical College, and Armstrong College, at Newcastle. In these it usually requires about three to four years to complete the equivalent of one year's work in a college with day seniors.

In Germany the most prominent engineering school is the Technische Hochschule, at Charlottenburg, just out from Berlin. This was established in 1879, but the department of naval architecture was not established till 1894. Here the student enters from a gymnasium after working in a shipyard for six to twelve months. The course is a four-years' course, and there is a distinct segregation of the work on hull and engines into two distinct branches, one man not taking both, and the degree given specifically states the branch taken. There are two sessions, October to April and April to August, and two examinations are required, one after two years' residence, and the other final. Practical work in the yards is a requirement for graduation.

In Japan, a course in naval architecture is given at the Imperial University of Tokio, consisting of three sessions of ten months each, September to July, and during the three years students are required to spend eight months in practical work. They are allowed to select the work, but the faculty supervises progress and reports to the university for marking. Tuition is $12.50 (£2/12/1) per session.

American Schools of Naval Architecture

In this country the parent school is the Massachusetts Institute of Technology, in which the course in naval architecture and marine engineering was started as a branch of the course in mechanical engineering about 1896. Here the course is a four-year course with the professional work beginning in the second term of the second year. Experience in shipyards during summer vacations is urged, but not required.

This college also maintains a course of naval construction which is a special course for the training of the naval officers who are to become naval constructors. These men are graduates of Annapolis, and have had sea experience before being sent to Boston for the technical training.

The University of Michigan has also maintained a separate course in naval architecture which in essentials is much like that just outlined.

So much for a statement of facts concerning the present status of representative major grade colleges, and it is readily noticeable that, allowing for minor variations, they all have these same essential features, approximately a four-year scientific course, instruction on the lecture system supplemented by text, and large periods devoted to design in the drawing room, which are intended to permit the application of the instruction in the lecture room to concrete problems. Practice in actual construction is, however, left largely to external sources rarely controlled by the college, and returning to the student much or little dependent upon circumstances and his enthusiasm.

Teaching Methods

Wm. Barton Rogers, the founder of the Massachusetts Institute of Technology (which was the pioneer in the laboratory system of technical education in this country), is credited with the motto "Learn by doing," and this was the basis of the success of that organization and is vital to the success of any engineering instruction. That this was clearly recognized by those responsible for the development of the course is evident by the effort made to follow up the lecture-room instruction on the major problems by actually doing similar ones in the drawing room. But *why was this not extended to cover the instruction given in ship and engine construction and manipulation?* The answer is threefold:

a. The manner in which courses in naval architecture and marine engineering came into existence.

b. The small number taking the course.

c. Expense involved to furnish proper laboratories.

Taking these up in the order given, we find—(a) that practically all of the courses were outgrowths of the mechanical or civil engineering courses, and where the laboratory system had been applied to them the attempt was made to utilize the laboratories then existing, with

perhaps minor augmentations and changes. Especially is this true of the institutions in this country where we had laid more stress on the laboratory system of education than in European countries.

(b) Naval architecture has always been a highly specialized course, and the need for graduates small as compared with the need for graduates from the two older parent courses. This has meant either smaller corps of special instructors for the students or their taking certain work in conjunction with sections of the larger courses; in which case the small group invariably suffers.

(c) The question of expense is, of course, a very important one, especially considering the chronic poverty of most educational institutions, and even if this unfortunate condition be not present it is improper to make large expenditures unless we get large returns. This matter has been far more of a bugaboo than it should have been. The greatest opportunity for improvement in this country lies along the direction of improved laboratory facilities and instruction in the so-called "practical details."

Instruction in Practical Details Lacking

For many years I was associated with the Massachusetts Institute of Technology, and during that time the criticism that most commonly came back to us was the deficiency in knowledge of details of construction or operation. We took the attitude then, and I believe the correct one, that it was impossible, *as equipped,* both as to personnel and material, to give complete instruction along theoretical lines and also give much attention to practical details. If either were to be sacrificed, it were preferably the latter. A man could get the latter away from college, but rarely the former, and it was better for a man to pick up the practical details after graduation and receive some compensation (though perhaps small) while doing it than to attempt to get this during an academic term for which he is paying tuition. Needless to say, this is the stereotyped argument, and the more I see of the results of the present system, and the closer I get to the graduates, the more certain I am that the criticism is to a large extent warranted.

Obviously, a course cannot survive without some attention to practical features, and, on the other hand, one devoted entirely to practical details simply becomes a vocational training course. As existing in this country and France, the connection with the practical details of actual practice has been only via the cheap and easy route of the drafting room of the college, which has resulted in a serious deficiency in training for men who go on to outside work.

Conditions in the Shipyards

In any country the growth of engineering courses follows the economic history of the subject taught, and in this country that history consists of two crests of activity with long periods of depression preceding. Considering modern training only, the first course in this country was established as a separate course in 1896 at the Massachusetts Institute of Technology, though it had been carried as an option in the mechanical engineering course for several years before that. At this time there was a gradual increase in shipbuilding activity, reaching the first crest in 1902 at the time when it was expected the shipping subsidy bill of Mark Hanna would be made law.

The failure of this measure to pass pricked the bubble of expansion in the shipbuilding industry and there followed a long period of depression, only ended by the enormous activity of the present time. Practically but two organizations of major grade survived that period of extreme depression and maintained separate courses of instruction in naval architecture and marine engineering. These were the Massachusetts Institute of Technology and the University of Michigan. Now, with the present activity many are reviving former courses and establishing new ones, but I have not yet seen any radical departure from the above orthodox course.

The situation is really serious, for the men now issuing from the colleges should be the ones responsible for shaping the development of the industry and form the skeleton of *highly trained* men, about which can be built the organization of both shop or yard and office. But with the deficiency in practical knowledge of even the commonest outside functions many will not find themselves until the crest has passed and the opportunities for advancement seriously curtailed, and the places which they should have taken will be filled by the man taken from the ranks or the lower grade training schools who is facile in construction details but usually lacking the sound fundamental training. This may result in apparent present success, but will be bound seriously to handicap sound and aggressive development in years to come.

This is the reason for the current discussion as to whether the engineering schools have made good in the present emergency, and to my mind in these subjects they have *not* made good, at least to the extent that they *should.*

Do not confuse, and do not imagine that I am confusing, the scope of the college course with those of the secondary or training courses, for I am not. But the principal criticism of the major courses to-day lies in *insufficient development of the training in practical construction and operation.* I do not believe in destructive criticism. If one has no remedy to suggest, good is never done by calling attention to defects. I will therefore venture my opinion as to the best correction for the above-mentioned fault.

Remedy Suggested

The trouble can be entirely eliminated by doing three things: (1) Enlarging the purely professional teaching personnel; (2) providing a proper laboratory equipment and courses, and (3) providing an effective alumni employment bureau.

The need for the first is almost self-evident. There should be a man of faculty grade to handle *each* of the major professional subjects, so that he can give complete attention to its presentation and receipt. Sufficient instructors and assistants should be provided to ensure sections in the drawing room not exceeding ten men, and in the laboratory not exceeding five. This, coupled with a good system of marking at frequent intervals, will ensure that the teaching of the fundamentals penetrates permanently.

The second, namely, proper laboratory equipment, is fully as important as the first. The idea that a proper laboratory equipment in this case means a shipyard is as fallacious as that an electrical laboratory needs the Niagara power plants; but who would consider the giving a course in machine tool operation without a lathe to work on? Is it not just as foolish to attempt to teach fabrication of steel members for a ship without a punch or shears? And yet I do not know of a single school in this country that has a shipyard punch or shears for instruction purposes in its shop or laboratories.

Nor can the argument of expense be legitimately forwarded, for the expense of a single power-producing unit in any modern mechanical laboratory will far exceed the

cost of the most ambitious ship tool that one could wish to establish in a ship-construction laboratory. A few of the principal shipyard tools of sufficient size not to be trivial, material to work with and a space for some erection, is surely a modest programme for a ship-construction laboratory; and for a marine engineering laboratory an equipment of the principal auxiliaries arranged somewhat like aboard ship, with customary laboratory facilities for operation and test, would suffice. The prime mover could be located in the mechanical laboratory if necessary and serve two purposes, and the boiler could be of the regular plant equipment.

Employment Bureau for Technical Graduates

Passing to the third suggestion, an efficient employment bureau, it is of as vital importance that any product be properly marketed as that it be properly produced. The first two items deal with improved production; this, with improved marketing of the finished product—the graduate. Most of the colleges of this country maintain more or less efficient organizations for answering requests for men. Usually the bulk of the actual work of selecting individuals for all the courses falls upon one or two members of the faculty, and this in addition to their other duties. If we are going to rely upon a man obtaining most of his practical experience after he leaves the college, and we must, even though we give him some, as suggested above, then the college should exercise careful supervision over the graduates' occupation on leaving, and should encourage frequent movement during the first few years after graduation. This employment bureau should keep in constant touch, not less than once a month, with the recent graduates. It should deal specifically with one department, and no other, though receiving requests forwarded from other branches, and should encourage rather than discourage changes that make for the advantage of the graduate; in fact, it should be almost parental in its efforts for direction and guidance of the graduates on matters of professional occupation and advancement.

It is considered against the ethics of the profession for individuals to advertise in certain channels, but there could be no objection to a properly constituted central body advertising by press and circulars to the shipping fraternity a list of anonymous individuals of various training, experience and capabilities, who wished to change their fields of activities. This would be a stable arrangement, as it would result in benefits to both sides—to the employer, in that he could see what the market had and current quotations, and to the graduate, in that he could change to a field that needed a man of his training, much more readily, and thus improve his changes for advancement.

Kinds of Employment Available

It should be one of the functions of this organization to cultivate new channels for the employment of graduates. I have found men so many times going directly into a shipyard simply because they didn't know there was any other place for them to go without changing their profession that I am convinced that both the public and the graduate need enlightenment on this subject. Of course, the immediate field is the shipyard and will always be the predominant user of graduates, but with a country with the shipping interests of this one there are many and varied positions that could and should use the trained technical man. Such places as naval architect and superintending engineers for the large steamship-owning companies, surveyors for the American Bureau of Shipping, resident constructors for steamship companies having vessels built, supervising inspectors for the United States Steamboat Inspection Service, with marine supply companies, purchasing agent, etc., etc., all would be infinitely benefited if filled by men of sound technical training. Proper publicity and advertising campaigns would result in opening up the lines to these positions for the young graduates and also in many cases for the older men, who may be side-tracked into routine work with limited prospect for advancement. I feel very strongly that the graduate should have an active, aggressive and, if needs be, selfish agent who will look after the *graduate's* needs first and to the best of its ability.

Let me briefly summarize; the courses as established are sound in their treatment of theoretical subjects and in the apportionment of time allotted to these subjects and to the application; they do not, however, use the time apportioned for the *application* of the subjects to good advantage. If the time available for drawing-room work and laboratory work were properly utilized in practical problems and in laboratories properly equipped for teaching details of construction and operation there would result a better trained graduate, one who would not go out into the field of his profession with the placid and complete ignorance of important details, as now frequently happens, but are equipped to stand shoulder to shoulder in practical work with the man coming to the task from the other route.

Standard Cargo Boat Built by Moore & Scott Iron Works

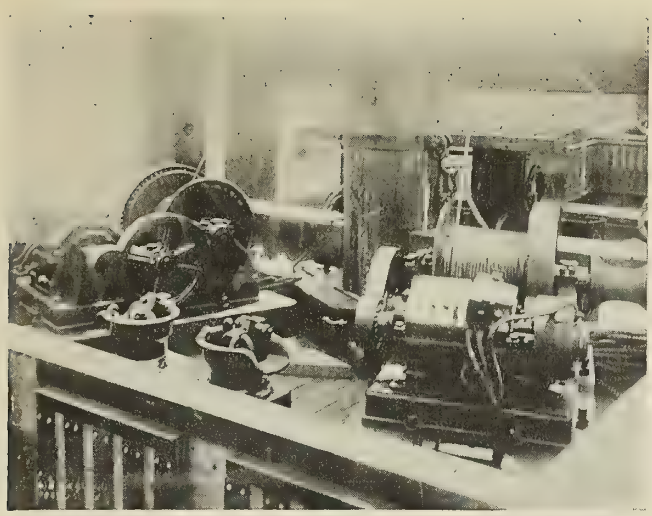
MOORE & SCOTT Iron Works, San Francisco, Cal., is prepared to build cargo vessels of a standard type capable of carrying 9,400 tons deadweight on Lloyd's summer freeboard (about 26 feet 4 inches draft). The vessel is of the shelter deck type, designed for a speed of 10½ knots and fitted with either turbine or reciprocating engines. The principal dimensions are as follows:

Length between prpendiculars	402 feet 6 inches
Breadth, molded	53 feet
Depth, molded to upper deck	26 feet 6 inches
Depth, molded to shelter deck	34 feet 6 inches
Cubic capacity, including 425 tons of coal in permanent bunkers, approximately	427,000 cubic feet
Cubic capacity, exclusive of permanent bunkers, approximately	411,000 cubic feet

Built on the Isherwood system of longitudinal framing, the vessel is of schooner rig with two-pole masts, each fitted with four 3-ton derricks. Cargo is handled through four hatches, each 20 feet by 33 feet, and one hatch 8 feet by 20 feet. Amidships there is a deep tank for water ballast. A refrigerating plant is provided suitable for keeping the temperature of the meat room at 24 degrees, and of the vegetable room at 34 degrees.

Propulsion is by a single-screw driven by either a reciprocating engine or steam turbine supplied with steam by either Scotch or watertube boilers. If turbines are installed, the boiler pressure is 210 pounds per square inch; if reciprocating engines are installed, the boiler pressure is 180 pounds per square inch. The designed horsepower of the engines is 2,400 and the coal consumption approximately 45 tons per twenty-four hours.

The auxiliaries include one 20-ton evaporator, one feed heater, two turbo direct-current, 110-volt, 10-kilowatt generating sets and one distiller of 2,000 gallons capacity. The deck machinery includes one 10-inch steam windlass on the forecastle deck, one winch on the poop deck with extended warping ends, eight 7-inch by 10-inch vertical winches for working cargo, and two 7-inch by 10-inch vertical winches for working the hatch at the bridge front.



Showing Minimum Deck Space Required for Winches

Electric Winches Are Operated and Controlled Easier than Steam Equipment

Electric Winches Gain Favor on Motorships

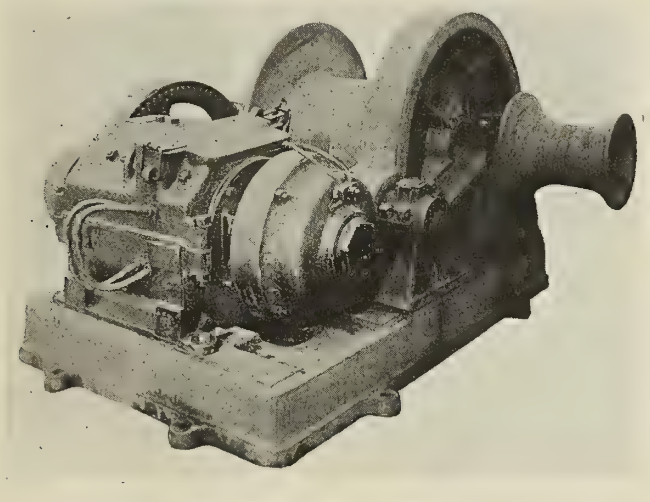
Record in Cargo Handling Attracts Attention—Fifteen Freighters Equipped by Seattle Firm—Economy Gained in Operation and Upkeep

WITH the advent of the motorship and the absence of the usual steam propelling power the question of power for auxiliary machinery on shipboard has been studied anew. Electric motors have been applied to much of the work, and in handling cargo the motors have been shown to be much more effective than the old steam apparatus. On September 1 fifteen boats had recently been or were being equipped with electric winches by one firm in Seattle, Wash., which has specialized in this line, and on those boats which have already been put in service very satisfactory records have been made.

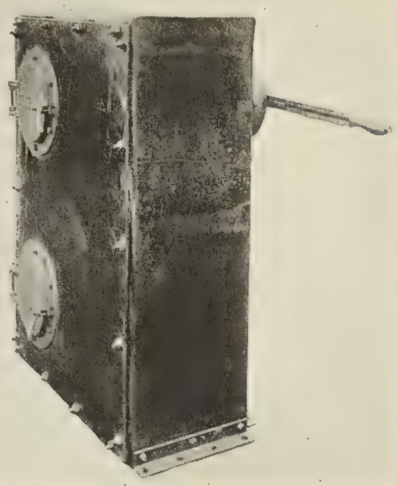
The first cost of electric equipment is considerably higher than for steam winches; but offsetting this are a number of important advantages. The electric winch is more economical to operate; it is claimed that it cuts loading or unloading time in half, affords much better control of the load, eliminates standby charges that increase steam operation costs when delays occur, makes the winches available any time on short notice and eliminates trouble from frozen steam pipes or cylinders. With the watertight motors now used, exposure does not affect the deck equipment, and with conduits properly installed the maintenance and repairs are believed to be below the corresponding costs on steam equipment.

Type of Equipment Used

Since variable speed at variable loads is essential, direct current is used exclusively, the specification calling for 220-volt Crane type motors. The installations referred to in the foregoing are as indicated in the accompanying table:



Single-Drum Electric Winch



Controller

Owner	Number of Ships	Winches per Vessel	Winch Power, H. P.	Winch Capacity, Tons
A. O. Anderson & Co.	3	6	15	2
A. O. Anderson & Co.	5	6	25	4
Libby, McNeil & Libby	1	6	20	3
Libby, McNeil & Libby	1	4	20	3
Alaska Pacific Steamship Co.	2	4	15	2
M. T. Snyder Co.	1	2	15	2
Independent Steamship Co.	1	4	10	1½

All but the last are 2,800-3,000-ton wooden motor ships.

The first of these boats to be put in operation was the *Astoria,* with six 15-horsepower, 2-ton winches. This boat went into service immediately after leaving the yards, and on the first day's loading green crews put aboard 453,000 feet board measure of lumber in eight hours. This is estimated to be about three times the amount of cargo that could have been handled with steam equipment. Moreover, conditions were adverse on this day, as a gale was blowing and 5 inches of snow lay over the lumber piled on the wharf.

The greater speed with electric winches is credited to the degree of control which the operators have over the load. It can be dropped rapidly to within a few feet of the bottom of the hold and then slowed down to enable it to be swung into place. The return of the empty hook is also made much faster than with steam winches. The 4-ton hoists on the *Astoria* handled capacity loads at about 100 peet per minute, and the same equipment, without change in gearing, lifted 2,500-pound loads at about 300 feet per minute on a single line.

The positive unwinding drive of the electric winch brings down the empty hook as rapidly as desired. Should the current fail during operation, the automatic brake will hold the load suspended until the current comes on again. The motors are protected against overload on low voltage by a double point circuit breaker and contactor panel. If an overload comes on the circuit breaker goes out and is cut in again automatically when the control lever is returned to neutral position. The winches thus far used are of the single-drum type, so two are required for each hatch. However, a single lever controls each winch, and no foot brakes are required. It is notable that levers and directions of movement are the same as in the old steam winches, so that new operators have no difficulty in "breaking in."

Saving in Cost and Space

The direct-current generators are usually put in the engine room, where space is not valuable, and are driven by Diesel or semi-Diesel stationary type oil engines. This saves deck space and keeps the generator sets where the engine room force can attend to them. The fuel consumption is remarkably low. For example, a Swedish motor ship with electric winches, which recently docked at Seattle, loaded and unloaded about 7,000 tons of freight, 14,000 tons in all, with an oil consumption of 1.7 tons, which is estimated to be about one-tenth the oil that would have been required to generate steam for steam winches to do the same work.

The usual comparison is that a Diesel engine driving a generator will consume less than ½ pound of fuel oil per brake-horsepower hour as against 5 pounds or more of coal per horsepower-hour that would be required for a donkey boiler and steam power. Losses on the electric conductor between generator and motor are negligible as compared to that in steam lines, not to mention the difference in efficiency between the electric motor and the reciprocating steam engine.

The Diesel engine-driving generators in the motor ship will take the same kind of fuel as the propelling engines, and takes its circulating water from the sea, thus dispensing with the separate fuel tanks, fresh water tanks. condenser and other inconveniences that are inseparable from the steam plant.

Trouble heretofore experienced with electric machinery above deck is believed to be due very largely to inadequate protection from salt air and water. As now installed, the motors are not merely weatherproof, but are made absolutely watertight. The controlling apparatus is enclosed in a watertight steel case with two watertight doors, which can be opened for ventilation during use. The lever shaft which operates the controller is carried through the side of the control case in a stuffing box, packed like a piston rod. Wires are led through watertight conduit. The motors are direct geared to the winding drum, and friction drums and hand brakes are entirely eliminated.

Just as the Shipping Bureau requires motorships to carry certain spare parts, so should the electric winches be protected against breakdowns that could not be repaired en route or in freight ports.

The vessels described in the foregoing have been electrically equipped by the Pacific Machine Shop & Manufacturing Company, of Seattle, Wash., under the direction of Allen Cunningham. The motors and control apparatus were supplied by the General Electric Company.

Propeller Shaft and Broken Propeller

The illustration shows an experience with a propeller and shaft due to working amid water mingled with sand under the following circumstances. The steamer was trading between Monte Video and Paraguay, and in the course of the voyage up river she fouled a sand bank; the engines were kept moving to get the vessel off. The chief

Damaged Condition of Propeller and Shaft

engineer, finding the engines to be increasing unduly in speed, reduced the steam inlet, but after some eighteen hours' work they were pulled up. When the vessel was brought into dock for examination it was found that the shaft, the original diameter of which was 6⅜ inches, was reduced to 1¾ inches, thus giving a play of 4¾ inches in the outer bearing of stern bush, while two of the propeller blades, which were of cast iron, were broken and the other blade of gun metal was buckled at the tip.

The shaft was lined with gun metal and the stern bush was similarly lined. The vessel has twin screws, and the illustration shows the port propeller shaft. The propeller is three-bladed, and at this period of its history was fitted with two cast iron blades and one of gun metal. Had the stern bush been fitted with injection lubrication or clean water pressure, to keep the sand out of the bearings, it is interesting to consider whether the damage would have been avoided, or at least minimized.—*The Marine Engineer and Naval Architect.*

Fig. 1.—Starboard Side of Sunken Tanker a Few Minutes After Buoyancy Was Given the Vessel by Compressed Air

Salvage of the German Tanker Gut Heil

Compressed Air Raises 6,000-Ton Vessel After Lying Five Years on Bed of Mississippi River

BY ROBERT G. SKERRETT

THE German tanker *Gut Heil,* a vessel having a load displacement of about 6,000 tons, has lately been refloated, after lying substantially five years on the bed of the Mississippi a half mile below the city of Baton Rouge, where the Standard Oil Company has large refineries. As a salvage achievement, the raising of the steamer is noteworthy because the successful wreckers had to combat very hampering conditions.

Fig. 2.—The Ship in Process of Righting

How the Vessel Was Wrecked

The ship had just finished taking aboard a large export cargo of oil in 1912, and was getting well under way from the plant when she fouled her screw with a chain cable, became unmanageable and was carried by the current down upon two other vessels, each of which cut through her hull plating. One wound was abreast the engine room and the other in the compartment just forward, and both on the port side. The *Gut Heil* filled rapidly and sank in a few minutes. Some time later the same year her salvage was undertaken, and the work progressed to a point in rather a promising fashion. Unfortunately, her buoyancy was not wisely controlled. With her bow rising sharply and her stern still down, she acquired a heeling moment that could not be checked. In consequence, she turned over far enough to refill and to settle to the bottom on her injured side, leaving her starboard side just about flush with the river surface. That unsuccessful effort to refloat the *Gut Heil* cost the Standard Oil Company—her underwriters—a matter of $125,000 (£25,600).

For more than four years thereafter the steamer lay undisturbed, abandoned by her insurers, and treasure

Fig. 3.—One Stage Further Along in Getting Back to an Even Keel. On the Left Air Is Escaping from a Relief Valve, while on the Right the Disturbed Water Is Due to Air Leaking from a Small Hole in the Temporary Sealing of the Wound in Compartment No. 7.

trove for anyone that might seek to effect her raising; but her position marked her an unpromising gamble, and no one seemed disposed to risk good money upon her until a short while back, when President Underwood, of the Erie Railroad, and a number of his friends provided the funds and employed the Yankee Salvage Association, of New York city, to essay the task, after the experts of the latter concern had made an examination of the wreck. The ship was refloated early in December, and that climax represented the culmination of two months of painstaking preparation and work.

Ingenuity Required to Remove the Silt

During her long submergence the tanker's cargo of oil escaped, and in its stead her various compartments became loaded with a round measure of 4,000 tons of silt. The salvors' first problem was to get rid of this mud in order to dispose of that troublesome deadweight and to facilitate a thorough examination of her internal structural condition. Three thousand tons of the mud was discharged by means of special apparatus built for the job. This was in the form of compressed air siphons—the compressed air serving the double purpose of stirring up the mud and of producing a "lift" to bring the silt to the surface. The arrangement was an ingenious and effective one.

Upon inspection, after the removal of the mud, the divers found that the centerline bulkhead, which extended from the engine space forward through all of the tanks, was not tight where it joined the decks above. Inasmuch as the wreckers had elected to depend upon compressed air to refloat the ship, it was necessary that the junctions with the two decks should be sealed. This was done under water by tapping the bulkhead from its upper side contiguous to each deck, doing the same with the decks at the neighboring intersection, and then screwing into place bolts with broad heads. Concrete was then molded about the bolts, forming, in section, a rectangular tie between the nearby metal surfaces. This binder made the junctions perfectly secure and air tight, so that each compartment could be dealt with separately in the distribution of water ballast or buoyancy. The two injuries in the side of the ship were closed by reinforced concrete.

Where possible, air connections for the pressure system were tapped into the starboard tanks through the upturned side of the *Gut Heil* and located at points where they would be low down when the ship began to right herself. All discharges from the mud excavators were brought to the surface so that the salvors could observe just what the apparatus were dealing with. This was a visible check upon the effectiveness of the siphons and the gradual removal of the silt.

For the purpose of centralizing the control of the final stage of the undertaking, all of the flexible connections to the multiple air taps in the various tanks were led to a swinging platform erected upon a temporary extension of the ship's bridge. This platform was pivoted so that it would accommodate itself to the changing position of the craft when rising and heeling to starboard upon assuming a level keel. Attached to an upright grid on this platform were two sets of gages—one set being mercury column gages and the other the usual type of dial gages. The mercury gages marked the buoyancy in the various tanks or compartments, while the dial gages indicated the amount of compressed air in reserve in the salvors' flasks, and, therefore, the available pneumatic energy for dealing with the situation. A complete set of valves upon the same stage made it possible to control every compartment to which air pressure was to be applied. The release of this pressure would permit water to re-enter a tank, while the application of air pressure would drive out the water and increase the buoyancy at that point accordingly. The wrecking master, standing upon this platform, had within

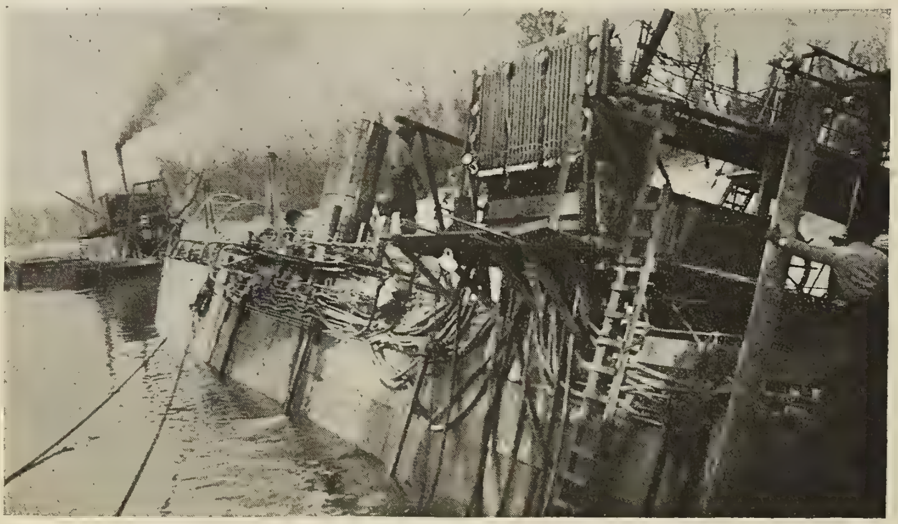


Fig. 4.—Photograph Showing Pivoted Gage Platform and Compressed Air Connections Centering There

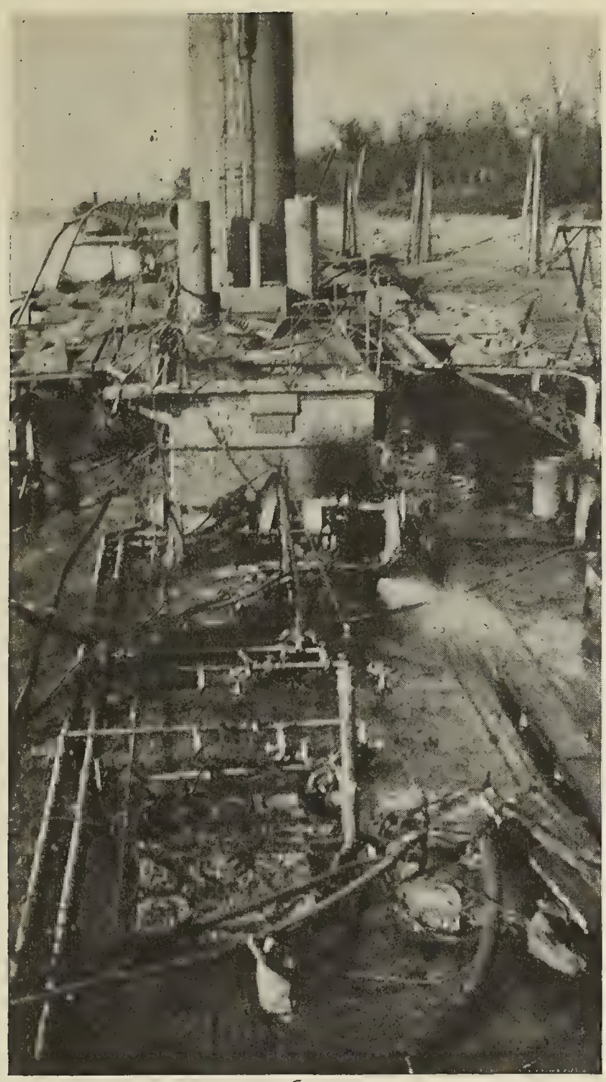


Fig. 5.—The *Gut Heil* Immediately After Her Refloating

a convenient compass everything essential to his perfect manipulation of buoyancy and water ballast, so that he could juggle these forces at any instant.

THE SECRET OF SUCCESS

The secret of success lay in keeping the *Gut Heil's* bow down as a sort of pivotal point while her buoyancy was increased from the stern forward and from her under side. In this way the boat was to be brought to the surface and heeled over until upright—the bow contact with the river bed serving to stabilize the operations by giving the wreckers, as it were, a footing on the ground. The previous unsuccessful attempt to refloat the tanker had emphasized the need of a nice check upon the vessel's lateral movement, lest the righting moment become sufficiently great to swing her too far over and to imperil a second sinking.

The tanker was first given sufficient buoyancy to just get her clear of the bottom and to make it possible to swing her into shallower water, where, when settling again upon her side, she raised her upper bulwark several feet above water and at a more favorable angle—that is to say, with her upper side no longer flush or parallel with the river's surface. With everything in readiness for the final effort, buoyancy was again given the submerged side, and the boat steadily righted until the top of her smokestack was showing above the tide; but then further movement was arrested by the readjustment of 1,000 tons of mud that had not been removed. This dropped away from upper surfaces, where it had been clinging, and thus changed materially the center of gravity of the craft. For something like three hours the *Gut Heil* hung at that point, and then, as added buoyancy was brought to bear, she gradually righted herself. The mud really served a useful purpose, because it acted like a counterweight and tended to play the part of a brake upon the vessel's angular movement.

After getting the tanker entirely afloat, the wreckers found her machinery in exceptionally good condition, notwithstanding its long submergence and its overlay of mud. In fact, nothing more radical than a good cleaning has been found needful to put her machinery in condition to carry the boat under her own power down to New Orleans for permanent repair. When the ship was sunk in 1912 it would have cost approximately \$300,000 (£61,500) to replace her. To-day, thanks to the increased value of seagoing bottoms, the craft is well worth a round million (£205,000). It is said that her present owners, if they sell her at that price, will certainly clear between \$700,000 (£143,200) and \$800,000 (£164,000) upon their venture.

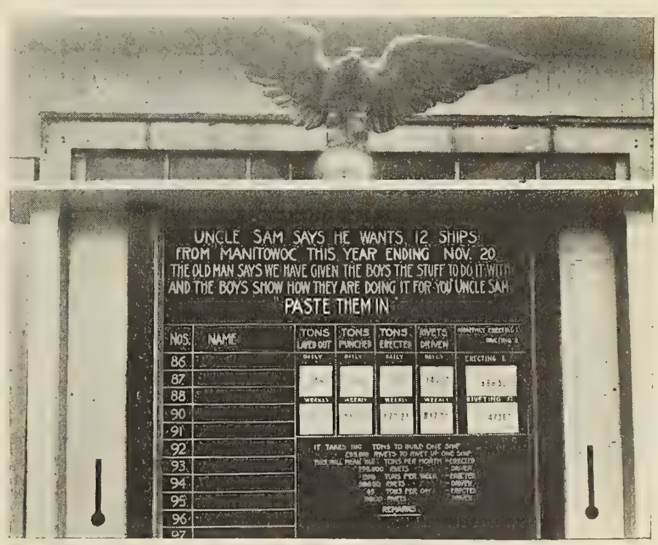
Shipyard Score Board

To indicate daily and weekly progress on vessels building in the yard of the Manitowoc Shipbuilding Company. Manitowoc, Wis., the bulletin board shown in the accompanying illustration has been erected by the company, with the result that a wholesome rivalry has been stimulated among the employees.

On the board is shown the daily tasks assigned to the riveters and to the erection men in order that the building programme may be completed on time; also a statement of the corresponding number of rivets and number of tons of material to be handled weekly and monthly.

The anticipated erection schedule by weeks is charted on one side of the board, and on the other is a corresponding schedule for rivets that should be driven each week. Against these desired amounts is marked in the form of a thermometer the actual progress in erection and riveting at the end of each week.

In this manner an immediate comparison is secured between the actual progress made at any date and the corresponding progress that should have been made. In other words, the bulletin board shows the workmen just what they have done and just what they should do. The bulletin, therefore, becomes the shipyard score board.



Bulletin Showing Progress of Work at Manitowoc Shipyard

Fig. 1.—Fifty-Foot Angle Furnace, Showing Preheaters, Vaporizers and General Construction

Economical Method of Burning Fuel Oil

Fifty Percent Increase of Economy Claimed for Sklovsky, or "Oilgas," Furnace Developed by General Combustion Company

WITH the great increase in the use of fuel oil for furnace work in the ammunition and shipbuilding plants, and the greatly increased prices of this commodity, all operators are looking at the present time toward any suggestion that will tend toward economy in its consumption. The General Combustion Company, of Chicago, has introduced a new method of burning fuel oil for which increases of economy as high as 50 percent are claimed. A claim of much less economy would be interesting at this time; but with a saving of approximately one-half the oil involved, the following explanation of the process as supplied by the manufacturers will be of interest:

The process is the result of an exhaustive investigation made by one of the largest forge shops in the country, which, realizing that the cost of oil was steadily increasing, sent its chief engineer on a six months' trip to England, Belgium and France, as well as throughout this country, with instructions to examine every possible substitute for fuel oil. The price of fuel oil has been continuously on the increase, and it was realized at this plant that some method must be obtained whereby they could decrease this enormous item of cost. It was thought possible that perhaps a producer gas plant would give satisfactory results. Also, the use of powdered fuel was given careful consideration. The result of this investigation proved that this shop could afford to pay as high as 15 cents (0/7½) per gallon for oil before a substitute would prove a better investment. The possibilities of decreasing the cost of fuel for this type of furnace were not in a substitute for fuel oil but rather in more efficient methods of burning it. The engineer mentioned set about a scientific study of fuel oil. He investigated its technical and mechanical properties and its behavior under various conditions of temperature and further influences. As a result, the Sklovsky method of burning oil was brought into effect, which resulted in the saving of 67 percent in fuel oil in this particular shop. After several years, the Patent Office has finally granted a broad basic patent, dated June, 1917, covering the complete process.

It is readily recognized by furnace engineers that the most efficient way of burning oil would be to burn it in a gaseous state. If the oil could be changed into a gaseous state, then complete molecular mixing could be accomplished without any trouble and with a great increase in economy. Under this improved condition, it would be possible to operate with just the theoretical amount of air necessary for complete combustion or 100 percent air. Combustion would take place much more rapidly and be completed in a fraction of the time needed before. It would now be possible to heat the stock with the gases after they had been thoroughly burned, so there would be

Fig. 2.—Preheater, Where Incoming Air Is Heated to High Temperature by Waste Gases From Furnace

no free oxygen to scale the stock. Using only 100 percent air would mean much higher flame temperature, and this would cause the stock to be heated much more rapidly. A still further economy could be made and still higher efficiency obtained by using the waste heat to preheat the air for combustion and to reduce the oil to its molecular state. Economy could also be made by reducing the furnace radiation losses.

Vaporization of Oil

In the *"oilgas"* furnace, vaporization of the oil takes place before entrance into the combustion chamber. Likewise, mixing of the vapor of the fuel oil with the air takes place before entrance into the combustion chamber. With these two conditions, the fuel entering the combustion chamber mixed in the gaseous form ignites more readily; in fact, almost instantly, and very completely. The fuel, therefore, burns with more nearly the chemically exact amount of air than is possible in previous types of oil-burning furnaces. The thorough mixing prior to entering the combustion chamber is accomplished by agitation that occurs in the vaporization chamber, due to the form of the chamber and velocity of the air, which is constrained to move alone without expansion. Another condition that exists in more rapid combustion in this new method is that the mixture leaving the vaporization chamber is approximately 800 degrees in temperature. It is necessary to raise this mixture only about 300 degrees in place of 1,000 degrees within the combustion chamber before ignition takes place.

The high furnace temperatures obtained by the *"oilgas"* furnaces are due primarily to limiting the quantity of air entering the furnace to a proportion nearly approaching that of the chemically required ratio. Also in a measure due to the preheating of the air. It is to be noted that the preheating of the air does not result in a like advance in temperature within the furnace.

The effect of temperature upon the rate of heat transference has been made clear through a set of experiments conducted during the year of 1913. It has been determined that to raise a piece of stock to a temperature of 1,500 degrees takes twelve minutes in a 1,600 degree furnace; four minutes in a 2,000 degree furnace; two minutes in a 2,500 degree furnace; 1.2 minutes in a 2,700 degree furnace. It takes, therefore, ten times the time to heat a piece of stock to 1,500 degrees in a 1,600 degree furnace as it does in a 2,700 degree furnace. The economy of more rapid heating under such circumstances is quite apparent, and particularly so in view of the fact that the oil required to obtain high temperature in furnaces does not increase with the increased temperature. This remarkable result is explained by the simple fact that as the temperature of the furnace increased and the vaporization obtained by better preheating of the air resulted in a reduction of the air supply required.

Fig. 3.—Vaporizer, Where Hot Air and Oil Are Mixed Into "Oilgas"

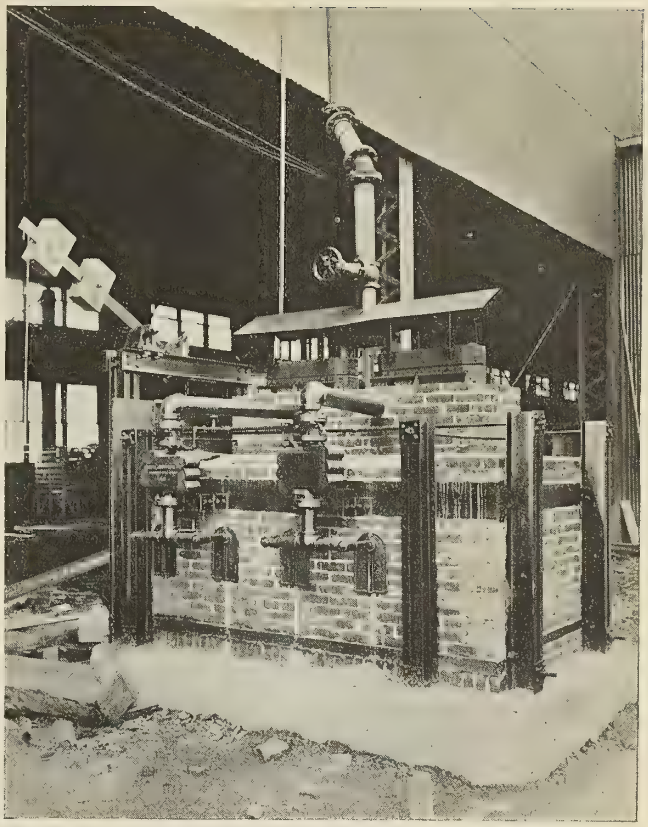


Fig. 4.—Small Plate Furnace, Showing Preheaters and Vaporizers

Construction of Furnace

The furnaces consist of the following principal elements:

(*a*) Air heating chamber and preheaters through which the air is forced under pressure and to which the heat is applied externally by the exhaust gases from the furnace.

(*b*) A mixing chamber, or vaporizer, through which the heated air is passed and to which the oil is introduced in a fine stream. The air and oil travel together, and, at the exit of this chamber, the oil has been gasified.

(*c*) The nozzle through which the mixture of vaporized oil and air, or *"oilgas,"* is forced at a high velocity into the furnace.

(*d*) Combustion chamber or furnace proper which is constructed to meet the particular requirements of the heating operations.

Aside from the above four principal elements, there are auxiliary parts, such as air control valves, oil control valves, nozzle and various piping connections.

The air preheaters are designed in such form that any number can be connected together to give the required heating area necessary to raise the temperature of the air to about 700 or 800 degrees with the furnace operating under ordinary conditions. These chambers are designed so that they fit uniformly into each other, no matter how many are used, and so as to have the least weight, taking into account the necessary strength required to withstand the heat and strain. They are also designed as compactly and simply as possible. The air streams cross several times so as to give a mixture of uniform temperature at the exit. Cast iron has proven the most satisfactory material for this chamber. Cast iron, however, must be free from steel, as, when subjected to excessive heat, there is a tendency to scale when steel is mixed with the iron. The design of the chamber is such as to eliminate all machine work. The joints are arranged with annular grooves in which asbestos wicking dipped in fireclay is inserted and the parts drawn together while wet and allowed to dry. This forms a sufficiently airtight joint to hold the low pressure that is applied to the casting.

Vaporizing Chambers

The vaporizing chamber is a single casting arranged to be placed near the nozzle of the furnace. The air and oil inlets are at the upper end. The chamber is designed so as to allow a traverse of the mixture of a distance of several feet before it reaches the outlet. The position of the chamber is such that it will automatically drain the oil downward. There is considerable latitude allowed, so that one vaporizer may be utilized for several different sizes of furnaces for different quantities of oil burned per hour. The position of this chamber should be such that it will not receive any material amount of heat from the furnace. It is also necessary to avoid pockets or low points where the oil will accumulate, as this will cause a variation in the instantaneous gas supply at the nozzle. The air connection and the vaporizer castings are not finished except for rough grinding. The flanges are made up with asbestos gaskets dipped in fire-clay and allowed to dry.

The Nozzle

The nozzle consists of a straight piece of pipe, long enough to reach from the fittings below the vaporizer through the outer wall of the furnace. Where it is desirable to spread the flame, as is the case when the nozzle is placed near the roof of the furnace, the end of the nozzle entering the furnace may be flattened. The size of the nozzle is determined by the minimum quantity of oil that is to be used in any particular furnace. As stated in the foregoing, it is necessary to have a velocity at this point high enough to avoid backfiring. The shape of the nozzle outlet in the furnace can be varied to give suitable flame distribution and it can also be divided into several units supplied from the same vaporizer.

The air connection to the furnace is made to a flanged ell which is fastened to the air heater. The other end of the ell is made special to fit into the annular ring of the heater casting. Any type of valve may be attached to this flange for controlling the air supply. Where the connection is made to the bottom casting of the preheater in place of the top casting is a special U-shaped fitting that is used in preference to the ell. On small furnaces, the connection between the heater casting and the vaporizer may be made by a single special casting that is adapted to fit into the space with the necessary connections to both the vaporizer and heater. On small furnaces, this has been found the most satisfactory arrangement. On large furnaces, regular fittings can be adapted for this connection, with the exception that it is necessary to use a special ell for the outlet from the heater casting.

The connection between the vaporizer and nozzle is made through standard fittings as indicated above, the heater castings, as well as the vaporizer, all being made for standard pipe connection. The nozzle is invariably smaller than the pipe connections supplying same. It is necessary, therefore, to utilize reducers at the outlet of the vaporizers to make proper connections to the nozzle. No special care is required in making the connections to the heater castings or from the heater castings to the vaporizer. As the air pressure used is low, the leakage factor is slight. However, the connections at the outlet end of the vaporizer must be made carefully, as, in that case, the air leakage carries with it oil leakage.

Oil Pipe Connection Simple

The oil pipe connection is made in a simple form, namely, by connecting a standard needle valve at the inlet to the vaporizer. The nipple immediately inserted into the vaporizer is made with a running thread, so that the nipple projects through the casting and drops the oil into the air current. The oil pressure at this point is only necessary to overcome the air pressure, which is not over one or two pounds. At the needle valve, therefore, a pressure of about two pounds is sufficient for actual operation. All excess pressure must be throttled down by the needle valve. It is to be noted here that the regulation is much more satisfactory when low oil pressure is used. This is on account of the grit that is present in the oil. When high pressure is used, a very slight turn of a valve or a change in the consistency of the oil makes a large change in the quantity of oil flow.

Starting up with the furnace cold, the process is similar to that used on the regular atomizing type of furnace. The air is turned on partially and a torch placed into the furnace in the vicinity of the nozzle entrance. The oil valves should be opened slightly, i. e., just cracked. As the air tends to heat up, the oil may be turned on gradually until the flame reaches out beyond the furnace. The vaporizing chamber at the start acts as a crude atomizer, and, as the air is heated, vaporization commences to take place. As also in the regular atomizing type, the initial oil required is greater than when the furnace is thoroughly heated up.

When the furnace is once heated, the starting during the day, after intervals of rest, does not, of course, require any torch.

In shutting down the furnace, the oil should always be shut off first, completely. The air pressure should be allowed to continue for a few minutes, full blast, so as to carry out completely all of the oil from the vaporizing chamber and its connection. The air should be then turned off, but not completely. It is best to leave the air blast on partly for a period of three to five minutes so as to cool down slightly the extreme hot surface of the furnace and thereby protect the nozzles from partial destruction.

The air heaters are so proportioned that they will give the required heat to the air for the average operation of the furnace. When furnaces are operated for appreciable periods of time idle, i. e., without any burden or stock, the escaping heat is necessarily high and the air chambers are overheated to an extent where the air may be given too high a temperature. To avoid this, the air heaters are by-passed, allowing some of the escaping gases from the furnace to be shunted to one side, to avoid overheating.

In addition to an economy of 50 percent in oil consumption, it will be seen from the above explanation of this

new process that positive control is afforded over both air and oil supply through the respective air and oil valves. The result of this is to enable the operator to secure at will either a neutral or reducing atmosphere in the combustion chamber according to the percentage of air mixed with the oil and thereby reducing all oxidation of the stock to a minimum.

Likewise, due to the high flame temperatures which are obtainable with the *"oilgas"* mixture, production can be greatly accelerated, and it is claimed for these furnaces that they can produce, an average of 50 percent more stock than is otherwise obtainable. Through the use of this process furnace work in shipbuilding can be made less costly and more efficient.

Fire Protection of Piers

Effectual Methods of Overcoming Fire Hazard on Steamship Piers

BY FRANK V. SACKETT

WITH the possible exception of shipbuilding, there is no more important problem in the country to-day than the proper protection of our war supplies from the danger of fire. Few people in the country realize the vast quantities of supplies that are now congested in our different seaports. When it is remembered that practically the entire output of our industries must necessarily pass through the various seaport terminals, it will be understood that every precaution must be taken to constantly protect them. Some idea of the amount of supplies can be gained from a statement made by Mr. A. H. Smith last March, to the effect that on that particular day 29,200 carloads of goods were being delivered to the North Atlantic seaports. The district of New York alone handles about 50 percent of the foreign commerce of the country, and in the last fiscal year this amounted to over four and a half billion dollars, including gold shipments, for that one port alone.

The safeguarding of these supplies against fire is much more difficult than might at first be supposed. In many cases the owners of piers have appreciated the crisis and taken extra precautions against fires, even adopting suggestions that did not appear to be warranted so as to leave nothing undone. The various authorities have also greatly extended their activity by increasing the number of inspections and rigidly enforcing all regulations, an excellent illustration of this being the order barring the public from access to pier property. Unquestionably this step will lessen, to a considerable degree, the danger from incendiary fires. There is no question of the intention of the owners or authorities to do the right thing to prevent fire, but the conditions are so serious that we can afford to take no chances. While the very concentration of these supplies makes them easier to supervise, it is also a serious matter, because such large quantities are subject to loss from one fire. There is no way at present that these supplies can be separated from each other, on account of the necessity of being near railroad terminals. The entire matter of fire protection of ports should be placed under some experienced authority, with proper facilities for making a careful investigation of the subject, and ample power to enforce any regulations. While there is no doubt that the authorities are doing the best they can at the present time, their authority is limited, and their duties are not always properly co-ordinated. An illustration of this is found in the laws governing the shipments of explosives, which supervise them up to the point where they leave the pier, but as soon as they leave the pier the protection regulations pass into other hands. Of course, this is wrong, as the same safeguards are necessary against fire on boats as at any other point. As a matter of fact, one of the most serious hazards to life and pier property is the possibility of fire on boats carrying explosives of any kind, which was recently demonstrated in the Halifax disaster.

The protection of pier properties involves special

Fig. 1.—View of Brooklyn Pier Equipped with Automatic Sprinklers, Showing Curtain Board Extending Transversely Across the Pier

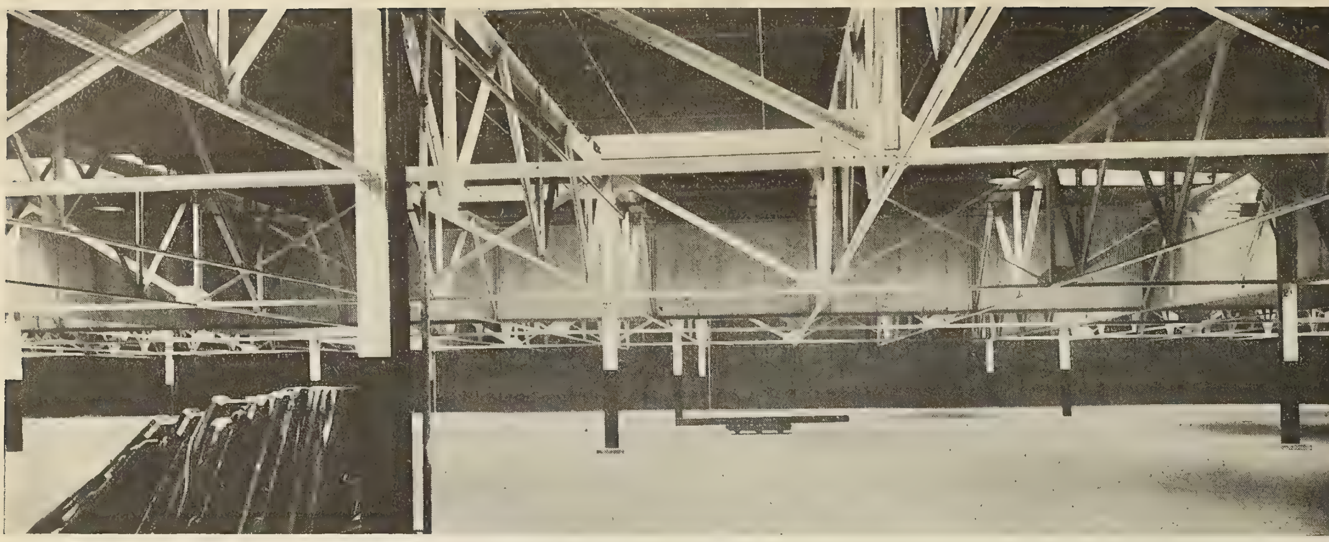


Fig. 2.—View of Brooklyn Pier Equipped with Automatic Sprinklers, Showing Curtain Board Extending Down the Center of the Pier

The curtain boards shown in this and the preceding picture divide the area in the pier shed and help to bank the heat of any fire at the sprinkler heads. A large number of fires on this pier have all been successfully handled by the automatic sprinklers.

hazards which require special attention and constant following up; and on account of the extreme importance of this matter, we outline briefly, in detail, the conditions found on piers.

Construction

Construction varies to a considerable extent, but, in general, tendency of the past few years has been to improve the type of buildings used for this purpose. No doubt good construction would be of material assistance in safeguarding against the danger of fire, but, unfortunately, the present crisis will not permit of sufficient time to change existing construction defects. Frequently we find fire-resistive construction in the more modern property, and a few sprinklered piers. Some are also found with fireproof floors and of slow-burning construction. In general, however, piers consist of one-story corrugated iron buildings, supported on wooden frames and wooden piles. Sometimes they are two stories, but always with high ceilings and large openings in the sides for loading purposes. Almost invariably they connect by unprotected openings with adjoining bulkhead buildings of ordinary construction and considerable size.

One of the worst features of piers is their large area, which is all open and subject to heavy drafts. Very seldom are these areas broken up by dividing walls. Unquestionably some good could be accomplished along these lines. For instance, fire breaks could be installed both above and below pier floors, which would prevent the fire from spreading so rapidly and thus give the fire fighters a chance. Owing to the fact that piers are subject to heavy vibrations and movement, a great many could not be protected with standard fire walls; but fire breaks would help considerably, and might be made of corrugated iron above the floor and heavy timbers below

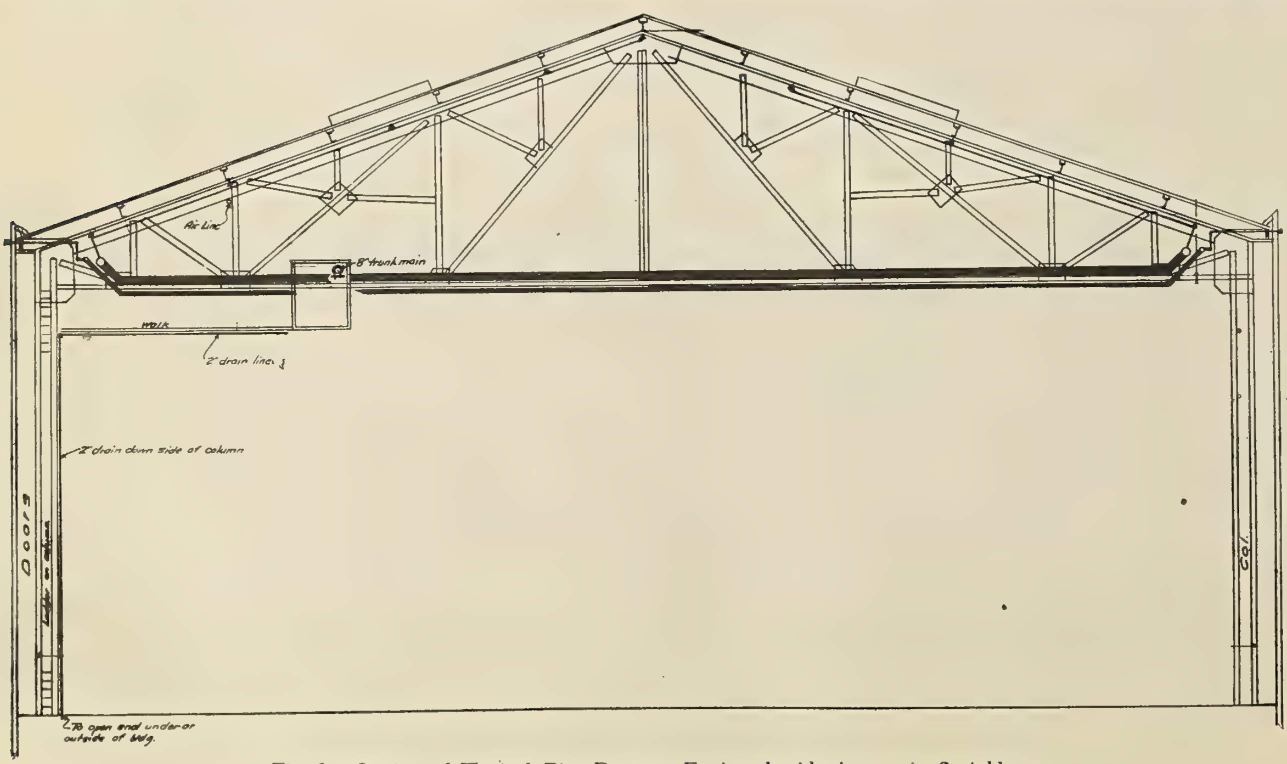


Fig. 3.—Section of Typical Pier Property Equipped with Automatic Sprinklers

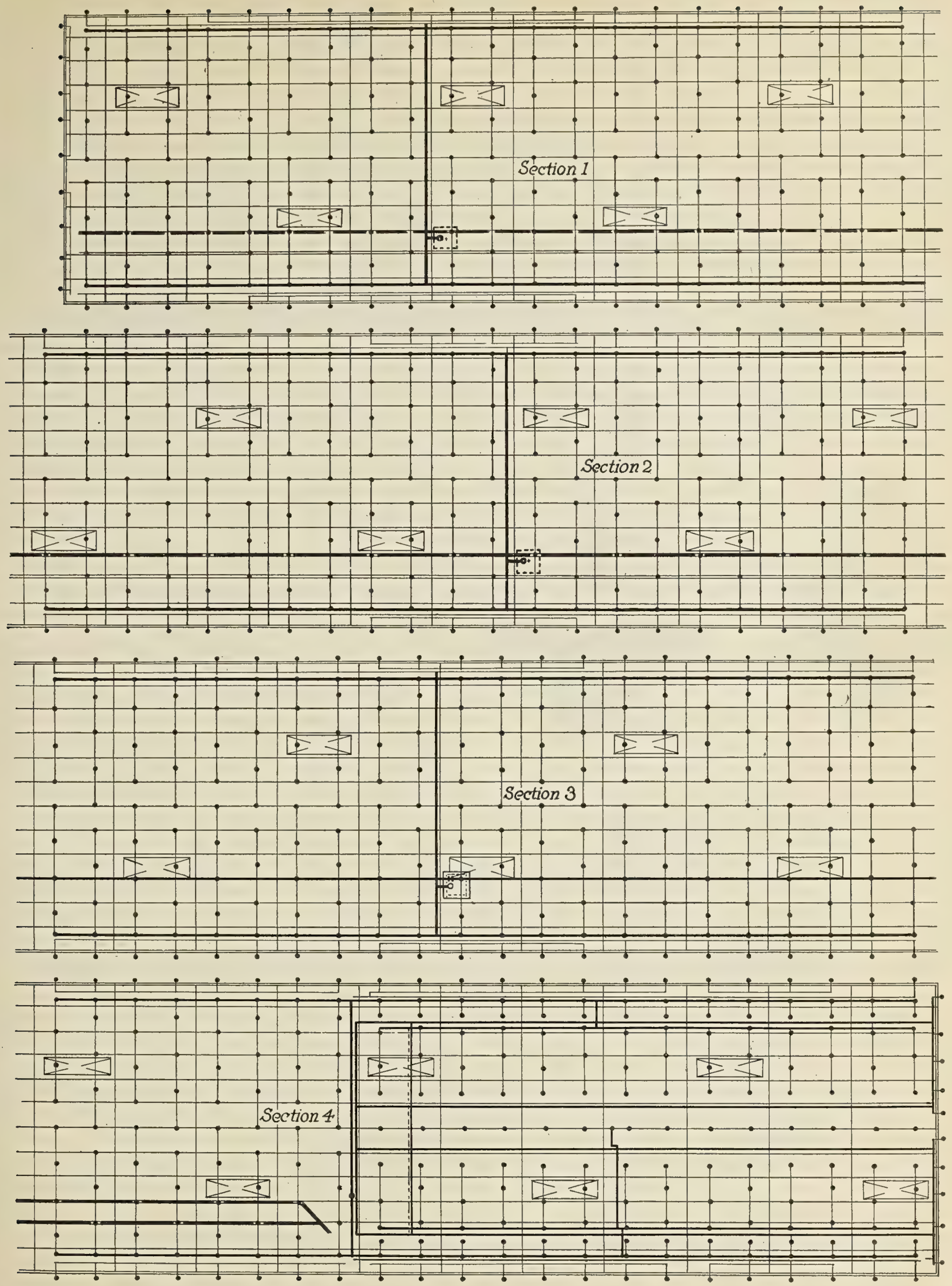


Fig. 4.—The Layout of Sprinkler System in Typical Pier Property. Note the Provisions for Sprinkler Protection against Exposure Fires and for Curtain Boards to Cut Up Ceiling Areas and Allow Heat to Bank at the Sprinkler Heads

the floor—a construction which would not be affected by the movement of the pier. While some objection might be made to this arrangement, on the ground that it would interfere with operations on the pier, it should be noted that piers with dividing walls are being satisfactorily operated.

Accessibility

From the very nature of piers, they are less accessible than ordinary buildings. Their location near railroad terminals or on water fronts means a frequent delay on account of congested traffic conditions. Furthermore, the ordinary building is accessible to fire fighters from all four sides, while piers are accessible only from one side, and that is always the short side. Approach from the water sides may be cut off by barges, blocking the slip, and regulations should be made to keep these slips clear, so that fire boats can approach from all sides.

Occupancy

The handling and storage of all sorts of supplies, from dangerous chemicals to aeroplanes, which must be received in whatever condition they are delivered by the transportation companies, is a dangerous operation. Furthermore, there is a constant change in the kind of material passing through from day to day, and this changing in itself produces a hazard, as elements that may be safe enough in themselves are frequently brought in contact with other elements which may cause them to be dangerous. Undoubtedly, one of the worst features about this miscellaneous stock is the trouble with broken packages and containers, and the constant spilling of the various contents about the pier, where they may cause trouble later on.

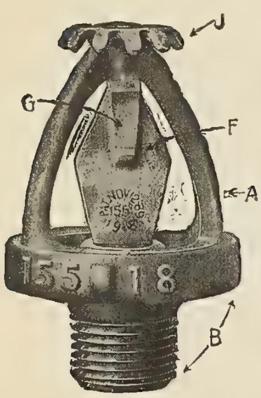


Fig. 5

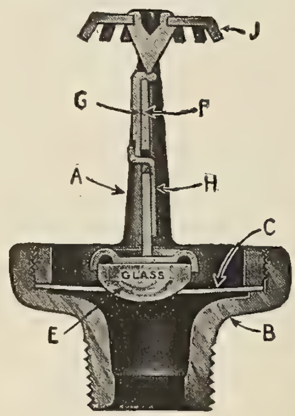


Fig. 6

Efficiency of automatic sprinkler protection depends upon the operation of the automatic heads themselves. Figs. 5 and 6 show details of one of the best-known types of head. The body *B* screws on to the tee in the line pipe. The yoke or frame *A* screws into the body and carries the deflector *J*. Between *A* and *B* is held a flexible diaphragm *C* with a ½-inch hole in the center. Into this hole fits the hemispherical glass valve *E*, held in position by a small metal cap and a strut of three pieces, *F*, *G* and *H*. These three parts are held together by fusible solder. As soon as the temperature reaches 155 degrees F. the disruption of the strut begins, and ultimately takes the form of a rocking motion, one part about the other. During this movement the flexible diaphragm with the full water pressure under its entire area holds tightly against and follows the glass valve until, as the strut finally falls apart, both valve and strut are thrown out into the room. Then a stream of water under full pressure, striking the deflector, is scattered in all directions in a hard-driven rain.

Chief Kenlon, in his book, "Fires and Fire Fighters," describes piers as, "comparable to nothing but horizontal flues, through which flames rush with a lightning-like rapidity, rendering abortive any efforts on the part of the fire department, unless the greatest promptitude is shown by all concerned."

Hazards

The *lighting* and *heating* hazards are about the same as in the ordinary building and apparently are well taken care of, but of course they must be continually followed up.

Smoking: No matter what regulations there are regarding smoking, it is a hard matter to handle. The danger from this source is always present and the only remedy is to keep after the matter and treat offenders severely.

Help: The scarcity of labor has resulted in the employment of undesirable and irresponsible help. It is a case of that or nothing, and certainly results in an increased hazard in handling. These men are not efficient and are not trained in matters of fire protection as well as in ordinary times. There is no remedy for this condition except a careful and continual watching of these men.

Exposures: Piers are subject to exposure fires, not only from adjoining frame structures on land and other piers, but also from vessels alongside, and floating material from other fires in the vicinity. They are much more susceptible to exposure fires than ordinary property because the high winds prevailing on the waterfront carry flying brands greater distances and fan these incipient fires wherever they start. An excellent illustration of this feature was the Jarvis fire, on the New Jersey waterfront, which spread across the river to a pier in New York. The vessels alongside and in the harbor are also hazards, because the employees on board are careless about fire protection matters, and are not under restraint by the pier owners. Frequently, boats containing dangerous contents catch on fire and they may expose several piers in the same harbor.

Fire Protection

Too much emphasis cannot be placed upon the necessity and importance of ample water supply for fighting pier fires, and yet, during this last winter, a large section of the New Jersey waterfront was greatly endangered by low pressure in the city mains. Reliable reports indicate that at the time of the coal shortage and very cold weather the city pressure at many points near pier property was *under ten pounds.*

This danger was somewhat offset by good private supplies, but simply indicates how bad things can get when not properly followed up. The size, location and condition of all mains and outside fire hydrants are matters that must have continual attention or they are liable to fail during an emergency. Instances of this kind have already occurred.

Inside Standpipe and Hose

For instant use with incipient fires, and to hold them until the fire department arrives, proper standpipe and hose connections are essential and are generally provided. It appears, however, that this form of protection is open to some objection not common in other property:

1. Subject to freezing, as shown by many cases that happened last winter.

2. Liable to be used by crews of boats alongside for purposes other than fire and damaged or left out of condition by them.

3. Frequently inaccessible or blocked by piling of goods too near hose racks.

4. Control valves are necessarily located out of reach and when the operator finds the fire too severe he is liable to run without stopping to close the valve, allowing the waste of water when not needed.

5. Condition of piping where salt water is used fre-

quently requires special attention on account of barnacles, pitting, etc. The only remedy for these conditions is constant inspection and frequent tests of the apparatus.

Extinguisher Pails and Casks

The value of this form of protection lies in the fact that everyone knows how to use them, and if used in time they may prevent losses. They must be looked after frequently to see that they are ready for instant use.

Watchmen

This is one form of protection that means much or little, depending entirely upon the watchman himself. In the past, the main trouble has been that men used for such purposes were not competent to fill the position, frequently being pensioners and others that were not physically fit. The importance of having strong, alert young men is becoming more apparent. When it is remembered that every night the entire protection of great values is solely dependent upon their good judgment and faithful efforts in a monotonous job it will be understood that first class men must be employed. It is also advisable to have a watchman's checking system, and he must be thoroughly instructed in detection and fighting of fire.

Fire Alarm

Both city and local fire alarms are desirable. The important thing is to give the alarm promptly, upon the discovery of the fire, as assistance cannot be rendered too soon. For some reason or other, there seems to be more trouble with delayed alarms, in connection with pier fires, than with other classes of property, and too much importance cannot be laid upon the necessity of early alarms for pier fires. Local fire alarm gongs operated from the same box are desirable for the purpose of notifying all employes immediately, and they furnish the best method of drilling them.

Fire Brigade

A well-trained fire brigade is a very great advantage because these men are constantly on hand and available. Their jobs depend upon getting the fire out. Further, on account of their familiarity with the property and the fire-fighting apparatus, they are able to get at the trouble very quickly. They should be under the direction of some experienced head and drilled regularly in their duties. They should know all about the apparatus and what to do in any emergency. They should be men selected carefully for their qualifications along this line; surprise tests should be made by the owners frequently to see whether they are properly responding to alarms.

Automatic Sprinklers

The value of these systems is well known, and where properly maintained there is no question as to their efficiency. Pier conditions require special consideration as follows:

1. They must be dry systems because the piers are not heated.
2. High ceilings and particularly draft conditions make necessary curtain boards to bank the heat at sprinkler heads for high efficiency.
3. Extra heavy water supplies are required because of the large area subject to one fire.
4. Outside sprinklers are sometimes necessary to protect from exposure fires on vessels, etc., that may be alongside of the pier.
5. Sprinkler supervisory service for the purpose of automatically calling in the fire department whenever a fire starts.
6. Proper housing for mains and dry valves to prevent freezing during cold weather.

When there is likelihood of the sprinkler pipes of an automatic sprinkler system being subjected to temperatures below that of the freezing point of water, a system known as the dry pipe system is used. This differs from the ordinary or wet pipe system, in that compressed air instead of water fills the pipes until a sprinkler operates, when the air quickly escapes and water is admitted. In order to thus control the flow of water, dry pipe valves are used. Their function is to exclude water from the sprinkler system until a sprinkler opens. The dry pipe valve, as manufactured by the General Fire Extinguisher Company for Grinnell automatic sprinkler systems, is shown in cross section in Fig. 7, and as it would appear in a sprinkler system in Fig. 8.

Referring to Fig. 7, *A* is the cast iron valve body molded in one piece, *B* is a dished malleable cover closing

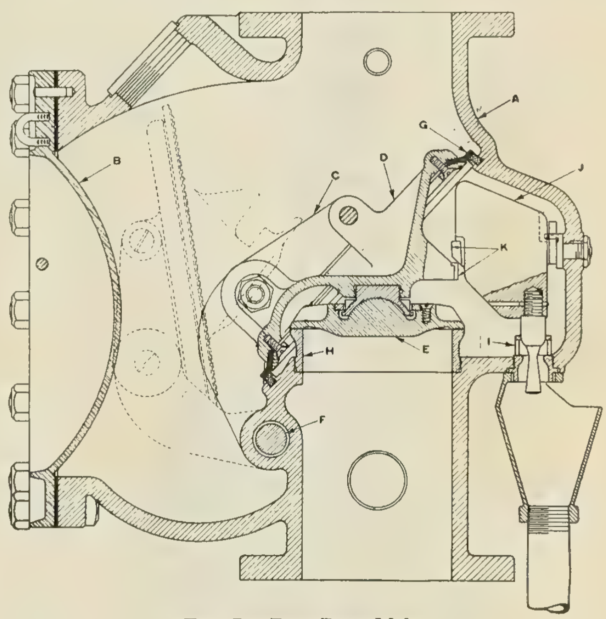


Fig. 7.—Dry Pipe Valve

a handhole conveniently located for setting and cleaning the interior parts. Two forged arms *C*, directly in line with each other in Fig. 7, and therefore appearing as one, cast iron member *D*, to which they are bolted, and bronze water clapper *E*, attached to *D* by means of the self-adjusting hemispherical joint, clearly shown, rotate as one piece about the bronze pin *F* and constitute the only essential moving member of the valve. The air joint is formed by rubber air valve *G* resting on a Babbitt seat, while *H* is the bronze water seat, raised well above the surrounding cast iron. The triangular space between the two seats is the intermediate chamber vented to the atmosphere through drip *I*. Slight opening of the clapper permits the latch weight *J* to fall, closing *I* and preventing reseating of the valve by engaging surfaces at *K*.

The operation of the valve is as follows: When the escape of air through an opened sprinkler has caused the air pressure on the upper side of the rubber air valve *G* to fall to about one-sixth of the water pressure acting on the under side of the water valve *E*, the clapper rotates through a small arc from its shut position, shown in full lines, to its open position, shown dotted, drip *I* being closed by the falling of latch weight *J*. This opening action occurs in a smooth and quiet manner without shock

or jar at any service pressure and is completely accomplished down to about five pounds per square inch water pressure. Once opened, the clapper cannot be reseated except manually after the removal of the hand hole cover *B*. In view of this it is evident that the main function of weight *J* is to close the drip *I*, it being probable that no service conditions will be encountered that would require its functioning as a latch.

The valve will open when the air pressure has fallen to about one-sixth the water pressure, or, as it is usually expressed, it has a ratio of six to one. An inspection of Fig. 7 shows that the air valve is but slightly more than three times the area of the water valve. The arrangement of the two valves is such, however, with respect to the axis of rotation *F* that the air pressure has the advantage of a leverage almost twice as great as that available for the water pressure, hence the ratio of pressures of six to one is obtained.

Turning to Fig. 8, the arrangement of the auxiliary piping and valves is seen. The use of these can best be

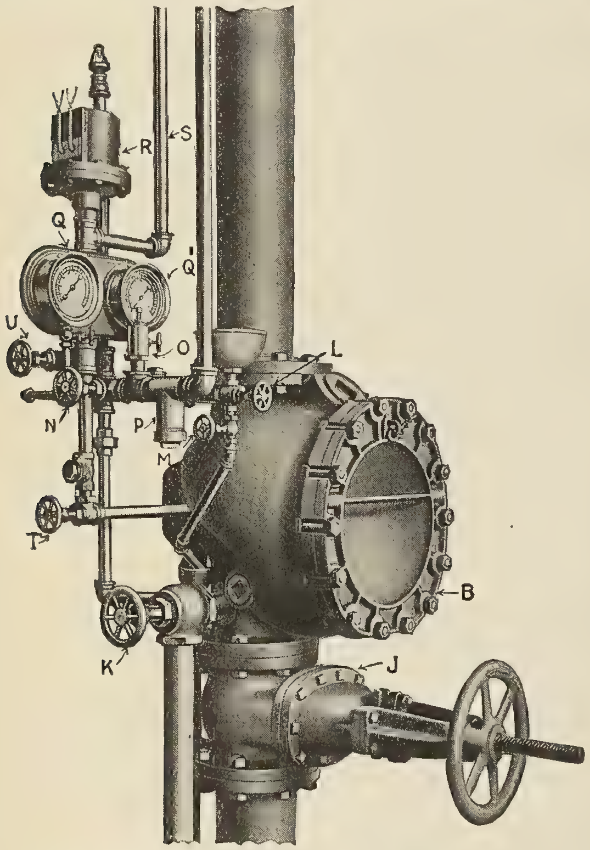


Fig. 8.—Dry Pipe Valve in Place in Sprinkler System

explained by assuming that the dry pipe valve has operated to extinguish a fire, and that we are called upon to put it back into service. Valve *T* is found open, and water flowing past it from the intermediate chamber causes operation of the electric alarm by means of circuit closer *R*, and continuing through *S* also operates the water motor gong on the outside of the building. As we know of the existence of the fire, these alarms have served their purpose, so we close valve *T*. After making sure that the fire has been entirely extinguished, gate valve *J* is closed and *K* opened, thus draining the sprinkler pipes of water. Hand-hole cover *B* is next removed. The rubber air valve, its Babbitt seat, the bronze water valve and its bronze seat are then carefully wiped and the clapper pushed forward until it falls into place. Next we raise the latch weight by means of the projection that extends through the drip valve opening as shown on Fig. 7 and then replace *B*, which is held on a short stud, so that both hands are free for inserting and tightening the bolts. This done, valve *L* is opened and water poured into the priming cup above it, the surplus being drained off through *M*. With *L* and *M* closed, *N* is opened until gage *Q* indicates that we have sufficient air pressure. Should we be careless and permit too much air to enter the system safety valve *O* will operate. Sediment strainer *P* prevents grit and scale from entering the dry pipe valve. After making sure that *T* is open and *K, L, M, N* and *U* closed, we open gate *J*, thus placing the system in readiness for the performance of its duty when next called upon. The water pressure is indicated by gage *Q*; valve *U* is a test connection which when opened permits the flow of water to the circuit closer and the water motor alarm for purposes of trial.

Monitor Nozzles

There is no doubt that in certain cases these nozzles can deliver large amounts of water that may be necessary for exposure fires, but there is some difference of opinion as to their value. The fact that they throw great quantities of water has some disadvantage, as there may be considerable waste. It is stated that on one pier property in the South the loss of pressure from the use of these nozzles resulted in the fire getting away from the fire department and destroying the pier. This undoubtedly was due to the improper handling of the nozzles, but where fire boats or tugs equipped with hose can be relied on to handle exposure fires they are more satisfactory.

As an example of the good work done along fire protection lines by pier owners, we mention the Pennsylvania Railroad Company, which operates piers at various points. In the first place, Mr. F. H. Newbern, superintendent of their insurance department, considers fire protection a regular business and handles such matters, through a picked corps of assistants, in a systematic, businesslike manner, paying particular attention to the constant following up of all details which are liable to be neglected. Mr. Newbern works along the well-proven plan that "the best time to fight a fire is several years before it happens." He believes in the careful training of the men that are working on the property, and insists that they all know the danger of fire and also how to fight the fire with the apparatus which is provided. "Keep things clear," is the first general order, and it is carried out, no matter how many brooms are required to sweep the rubbish, waste, etc., where it can do no harm. "Call the Fire Department" is the second order, and this is done before any move is made to fight the fire. They don't believe in taking any chances with fire that might get away from them. "Give it water" is the next order, and they believe in plenty of water being right handy. In Jersey City they carry a pressure on their private supply of about 100 pounds and can supply twelve streams with their three pumping stations.

Incidentally, their engines are also equipped with hose for fire-extinguishing purposes. All their tugs are ready for fire duty, and act immediately when the alarm is given. Their fire brigade is composed of selected men acting under orders of an experienced chief. They are regularly drilled in their duties and the actual handling of all fire equipments. A fire marshal, with no other duties, has direct supervision over all matters of fire protection, and makes regular and surprise tests to see if the men can be caught off their guard. Inspections are made of their own premises and that of adjoining property. Any improvements that can be noted are im-

mediately carried out. One of the precautions taken is to see that small boats are kept ready with necessary apparatus for fighting fires that may occur under the pier.

On account of the danger of incendiary fires, they have not only added extra help and increased the vigilance in watching workers on the pier, but have also provided extra lighting facilities and flood lights for illuminating the outside of the property at night. Care is taken to separate inflammable material from other goods and isolate same as far as possible on open piers. The alarm system is tested daily and is always used to notify the employes in any emergency. The keynote of the successful record of the Pennsylvania is in the fact that they recognize plain, common, everyday *carelessness* as the cause of most fires and realize that constant and continual vigilance is the only way to combat this enemy. "Keep clean," "Preparedness," with "Plenty of Water" is certainly a good remedy for any buildings subject to fire.

As to the chances of fire on piers, it may be noted that during 1916 the total loss of pier buildings (not including contents) was under $600,000 (£123,000) for the entire country, according to the National Board of Fire Underwriters. Last year's figures are not as yet available, but we have only to cite the following fires to be convinced that the losses on this class of property are piling up rapidly,

Atlantic Coast Railway, Charleston, S. C.	$ 22,000	(£ 4,520)
Lehigh Valley R. R., Fairhaven, N. Y.	25,000	(£ 5,140)
Panama Railway, New York City	20,000	(£ 4,100)
Pier 26, Brooklyn, N. Y.	1,000,000	(£ 205,000)
Saxon Motor Co., Detroit, Mich.	50,000	(£ 10,250)
Baltimore & Ohio Terminal, Baltimore (Estimated)	5,000,000	(£1,025,000)

and the present year has also started out badly, as illustrated by the Port of Newark fire.

Considering the serious hazards in pier property, it is a surprising fact that only a comparatively few piers have been protected with automatic sprinklers. For example, we find only one or two standard sprinkler equipments out of some hundred and fifty piers in Manhattan. Brooklyn has a better showing, with eighteen sprinklers, and New Jersey with about a half dozen. In the entire country, there are only about sixty piers safeguarded with sprinklers.

The probable reason for such a low percentage of sprinklered piers is the fact that these properties are largely owned by railroads, and they have been so hampered by different regulations in the past ten years that they were unable to obtain the necessary funds for these purposes, although the conditions are so severe as to warrant this expenditure, even in ordinary times.

We find that it is practically the unanimous opinion of all the fire protection engineers that sprinkler systems afford the best possible protection for this class of property, and many of them believe it to be the only satisfactory form for their particular conditions.

Mr. E. P. Boone, of the New York Fire Insurance Exchange, has had more experience with sprinklered piers than anyone else in the country, and he is an enthusiastic believer in sprinkler systems for piers. His experience covers a number of actual fires which have resulted in only nominal loss to the property on account of the quick action of the sprinklers. He mentions one case where fire opened some twelve sprinkler heads which extinguished the fire so promptly that there was no interruption to business. Although the smoke was thick, the drivers continued to operate their motor trucks, loading and unloading as though nothing had happened.

Figs. 3 and 4 give a good idea of the way Mr. Boone adapts sprinkler protection to the special conditions existing on a pier. Large open areas are broken into sections by special curtain boards coming down from the ceiling, which bank the heat at the sprinkler head in spite of the drafty conditions. Note that some curtain boards are parallel with the pier and others intersect them at right angles, running across the pier together, forming large pockets for the heat to rise in. This construction is rather unusual and is made necessary on account of the extreme width of the pier. One view also indicates the great length of the pier. These views show one of a group of sprinklered piers owned by the Bush Terminal Company, whose property was recently taken over by the Government.

The following piers are protected with sprinklers, and located in the New York district:

Baltimore & Ohio Railroad Company, Pier No. 66.
Lehigh Valley Railroad Company, Pier No. 5.
W. R. Grace & Company, Pier No. 33.
Barber & Company, Pier No. 36.
New York Dock Company, Pier No. 39.
New York Dock Company, Pier No. 40.
American Manufacturing Co., Milton Street Pier.
American Sugar Refining Company, 3d Street Pier.
United States Steel Products Company, 29th Street pier.
Pier, Foot of 35th Street, formerly Luckenbach Steamship Company.
Norwegian American Line, 30th Street Pier.
Hamburg American Steamship Company, Pier No. 134.

Instances of other piers that are sprinklered, in different cities, are:

Commonwealth Pier, Boston, Mass.
State Pier, Providence, R. I.
Delaware, Lackawanna & Western Railroad, Hoboken, N. J.
Mystic Wharf Dock, Charleston, Mass.
Norwich Line Docks, New London, Conn.
San Pedro Docks, California.
White Dulany, Seattle, Wash.
Port of New Orleans, New Orleans, La.

At this time there is nothing of more importance than the conservation of all our resources and efforts. No amount of money could replace the loss of our war supplies and terminal facilities. A fire on one of these piers would badly interfere with our operations here, and might easily affect our war program abroad. The absolute protection of this property is most vital and it has not received the attention its importance deserves.

"Everybody's business is nobody's business," and we firmly believe that serious trouble will result unless the entire matter is handled in a businesslike manner by some high authority with broad experience in this line. We submit:

1. That there should be no question as to the reliability of all water supplies involved, either public or private.

2. That lighters and boats exposing piers should be compelled to conform to established fire protection practice and not be permitted to endanger this property by using kerosene lamps, cooking stoves, etc.

3. That dangerous chemicals, oils and highly inflammable materials should be segregated and kept separate from other supplies.

4. That barges and boats should not be permitted to block up slips, preventing access to the sides of piers.

5. That extra large areas should be divided by section walls or fire breaks.

6. That explosives, or explosive materials, should not be permitted near the important terminals.

7. That bulkhead buildings should be cut off from piers, wherever possible.

8. That sprinkler protection should be provided where conditions appear most serious.

9. That good reliable watchmen should be employed at night to properly safeguard the contents.

10. That all dirt, waste and rubbish should be immediately removed and the premises kept scrupulously clean.

11. That, wherever lacking, all necessary fire-fighting apparatus should be provided and constantly tested and inspected.

12. That there should be a uniform practice established for handling all these matters, and particularly seeing that they are followed up from day to day.

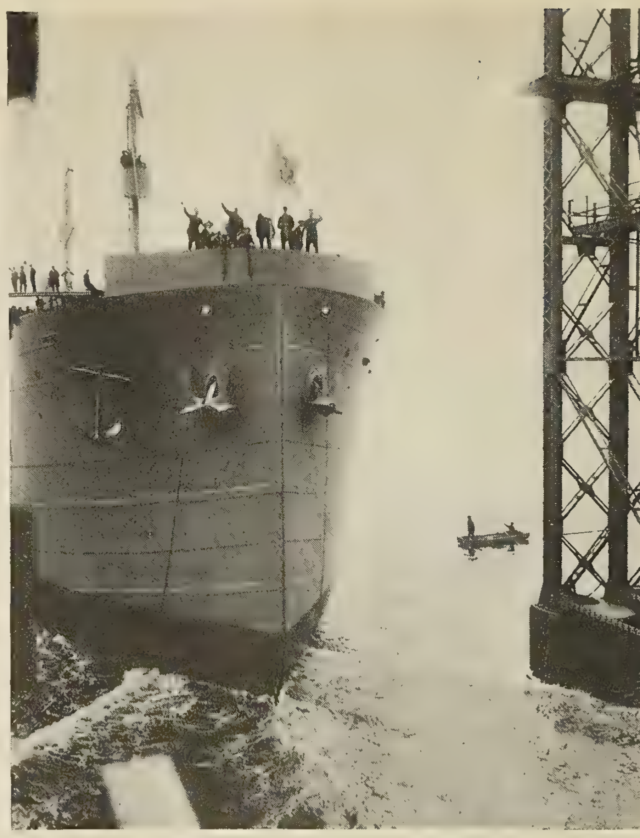
In our opinion the desired results can only be accomplished in one way: the Government must create a special central authority with necessary experts to make a complete study of the entire situation in all our seaports and then place the responsibility of handling and following up such matters in this one central authority. It must be more than an advisory body, and should be composed of men with practical experience in such matters, and capable of enforcing the necessary regulations. This step is not only justified, as a matter of business expediency, but is, in reality, a matter of military necessity.

These supplies on our piers are the real sinews of war. They are the things we bought with money from Liberty Bonds and are all finished, packed and ready to go where they can help win the war. They must be well safeguarded against fire at any cost.

Five Thousand-Ton Collier Built in Thirty-seven Days

A world's record for speed in shipbuilding has been established by the New York Shipbuilding Corporation, Camden, N. J., by delivering the 5,000-ton collier *Tuckahoe* in thirty-seven days after laying the keel. The keel was laid on April 8. Three days later all the bottom plating was laid, the inner bottom floors in place and the tank top plating laid ready for the bulkheads.

The vessel was launched 95 percent complete on May 5, just 27 days, 3 hours and 5 minutes from the laying of the keel. On May 16, thirty-seven days after the keel was laid, the vessel was turned over to the Government.



Launching the *Tuckahoe* Twenty-seven Days After Laying the Keel

The *Tuckahoe* is a collier of 5,500 deadweight tons, 332 feet 6 inches long overall, 49 feet 3 inches beam and 27 feet 6 inches molded depth. She is a sister ship of the S. S. *Freeman* described in our February issue.

Immediately after the *Tuckahoe* had finished her trial runs, she was docked at the Curtis Bay pier at Baltimore, where, in the record time of two hours, a cargo of 4,992 tons of coal was taken on board. Fifty-five minutes later the cargo was trimmed and the vessel was on her way to New England ports.

S. S. *Tuckahoe*, Built by New York Shipbuilding Corporation, Camden, N. J., in Thirty-seven Days, Establishing a World's Record for Speed in Shipbuilding

Welding Ship's Parts Together

Electric Welding Committee of Emergency Fleet Corporation Developing Methods of Welding Ships with Electric Arc

BY JAMES G. DUDLEY*

WITH the opening of a shipbuilding era in the United States, the native Yankee genius of adaptability (not being a shipbuilding nation) naturally turned to an investigation of methods of fabricating steel for the wholesale "manufacture" of ships other than those conventionally employed for the "building" of a ship. The method logically suggesting itself to skilled inventors, technicians and mechanics was to employ the "welding" means which are fast revolutionizing railroad repairs and fabrication and which have made possible countless modern machines and processes.

The "welding" methods now commercially available for joining together the steel members of a given structure are:

1. "Smith" Welding:
   (*a*) pure.
   (*b*) resistance: (1) butt method; (2) spot method; (3) seam method.
   (*c*) water gas.
2. "Fusion" Welding:
   (*a*) Flame blowpipe.
      (1) oxy-acetylene.
      (2) oxy-hydrogen.
      (3) oxy-coal gas.
      (4) oxy-carbohydrogen.
      (5) oxy-thermalene.
      (6) "Blau" gas.
   (*b*) "Thermit" Welding.
   (*c*) Carbon arc.
   (*d*) Metal arc.
      (1) bare electrode.
      (2) coated electrode.
         (*a*) gaseous flux process.
         (*b*) liquid flux process.

Fig. 1.—Welding a Skylight on Board Ship

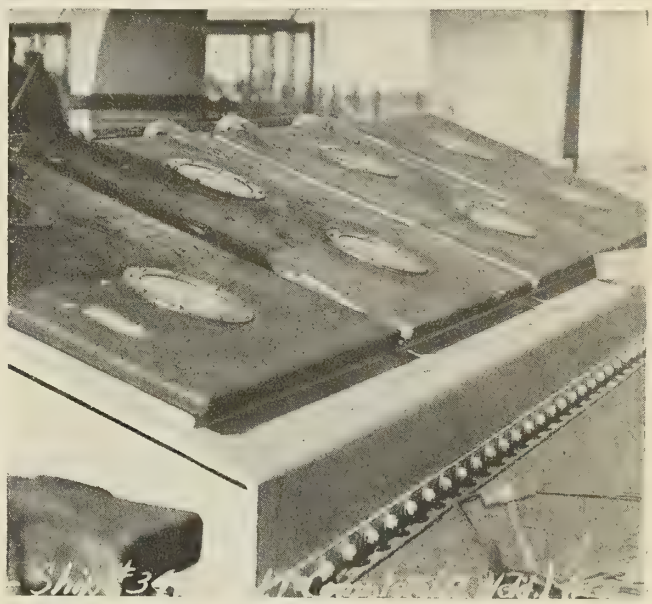


Fig. 2.—Skylight Completely Welded

It is not the purpose to here present an exhaustive technical analysis of the many and varied phases of welding, but rather to outline the status of this art, with reference to its applicability to, and adoption in, shipbuilding. Before considering the application of welding strictly to marine work, it is well to review its use in railway service.

At the outset it will be understood that there will be eliminated from this review all employment of: (1) "Smith" welding and (2) all "fusion" welding save the "metal arc" processes. For more than five years past the railways of the United States have been employing metallic electrode welding in largely increasing amount and with astonishing technical and economic gains in securing practically leakless conditions of the tubes and furnace sheets of the locomotive boilers. While electric welding has not—so far as known—supplanted riveting in this particular service, yet railway experts admit that but for its employment such giants as the Mallet-compound locomotive could scarce be kept on the rails. For more than seven years the Chicago, Burlington & Quincy Railroad has been successfully operating a fifty-ton gondola freight car completely fabricated by means of electric welding. The Rock Island System is claimed by its electrical engineer (Mr. Wanamaker) to be saving over all other methods more than $200,000 (£41,000) annually in repairs and fabrication by the use of electric welding.

"When completely equipped," states Mr. Wanamaker, "electric welding will effect savings of more than $1,000,000 (£205,000) annually."

The technical literature of railways and welding demonstrates beyond successful controversion that jointures of more than 100 percent efficiency can be readily and commercially secured by electric welding means. Even the truly remarkable results secured under the punishing

* Research and Experimental Engineer, Chester Shipbuilding Company, Ltd., Philadelphia, Pa.

conditions of steam locomotive service have not as yet overcome the friction and inertia of "standard practice" in so far as the design and fabrication of a complete locomotive is concerned, but eventually the insurance and inspection interests must voluntarily "approve," or be compelled by the march of events to "permit," the fullest possible use of electric welding in this field of transportation.

Passing to marine practice, it is more or less common knowledge in nautical circles that electric welding has been successfully and economically employed for many years past in many ports of many countries in repairing of parts of ships which otherwise must have been tied up for costly periods. The urge of war conditions has for several years past stirred the inventive and progressive genius, not only of foreign nautical experts to seek improved methods of ship fabrication, but has roused native Yankee "landlubber" skill to do likewise. For upwards of two years considerable welding work on ship's plates and parts has been carried out under working conditions, not only by the British Admiralty in England, but by private interests in Newburgh, N. Y., and Chester, Pa., yards.

As a result of certain newspaper publicity given to the subject, as a result of an address by the author before the Philadelphia Builders' Exchange, in December, the merits of "melting ships together" came to the attention of Secretary Franklin K. Lane, of the Department of the Interior, who later brought about official action in the creation by the Emergency Fleet Corporation of an Electric Welding Committee. This Committee has held a number

Fig. 3.—Filling Holes in Reverse Angles by Electric Welding

of organization meetings and now represents a large, growing and representative personnel of nautical as well as "landlubber" technicians, under the able chairmanship of Prof. C. A. Adams, of the Massachusetts Institute of Technology, with Mr. E. A. Stevens, Jr. (late of the United States Shipping Board staff) as secretary.

The Emergency Fleet Corporation has already authorized the building, at the Newark Yard of the Submarine Boat Corporation, of an experimental fifty-foot section of a 9,000-ton ship completely electric welded. In carrying out of this particular work, every known phase,

Fig. 4.—Section Model of Electric Welded Keel

apparatus and process will be given ample opportunity to prove its claims for consideration, and, in addition, the special skill and genius of proven or potential inventors will be given a chance to demonstrate their particular concepts.

Further steps have been taken to start a training department to create a reservoir of skilled welders against the inevitable demand, as soon as the requisite Governmental and Classification Societies' "approval" has been obtained to actually construct vessels or parts thereof by "melting" instead of "riveting." The unanimous conviction and expressed programme of the Electric Welding Committee augurs greatly enhanced speed in the "manufacture" of our ships, especially since expert judgment conservatively estimates that: "Four welded ships can be built for the cost of three riveted ships, and one which is 'melted together' will require but half the elapsed time for complete fabrication."

The British Admiralty have by this time launched a cross-channel barge of some 200 tons deadweight, completely electric welded.

Steps have just been consummated between the Emergency Fleet Corporation and the Welding Committee looking to the immediate preparation of designs "of a 7,500-ton electrically welded merchant ship of a standard construction, with only such changes as do not involve serious modification of the materials on order"; and "of a completely welded ship designed particularly to take advantage of electric welding methods to the maximum degree"; and "of a shipyard for the construction of only such electrically welded ships."

Oil Shales Reserved for the Navy.—In the annual report of the director of the Geological Survey, Department of the Interior, just made public, attention is called to the creation of two naval oil reserves in Colorado and Utah. The Survey has been investigating the oil shales of the United States that give the most promise of yielding a commercial supply of oil, and has explored large areas in Colorado and Utah that contain immense deposits of such shales, some of which carry 30 to 50 gallons of oil to the ton. This potential resource is estimated by the Survey in terms of billions of barrels of oil, which, it is believed, can be economically extracted from the shales, possibly in competition with the petroleum at present prices. It is therefore of special interest to note that during the last year two oil-shale reserves were created for the use of the navy, one of 45,440 acres in Colorado, and one of 86,584 acres in Utah.

General classification of oil-shale land was continued by the Survey during the year, the work covering large areas. Geologic examination of the oil-shale region of the West has shown that the oil shales in Utah and Colorado contain enormous quantities of petroleum. They also contain a considerable percentage of nitrogen, aggregating a vast supply, which can be recovered as a by-product in the refining of the shale and used either as a fertilizer or in the manufacture of explosives.—*U. S. Geological Survey Press Bulletin, No.* 349, *December,* 1917.

Training Shipyard Workers by Emergency Fleet Corporation Methods

(*Concluded from page* 328.)

instructors of wood shipbuilding. An expert is employed in the training center for the purpose of determining exactly how much of the new trade shall be given to the conversion man to fit him out as an instructor of the particular shipyard trade.

The most encouraging feature in connection with the establishment of a training center in the shipyard is probably the reduction of labor turnover, together with the fact that a green man is much more likely to apply for a position in a shipyard where he knows that a training department exists specially to train him.

The Emergency Fleet Corporation makes an allowance to the shipyard of one dollar per day for each man trained in a training department, fifty percent of which goes to the man if he remains in the yard *seventy-eight days.* This alone tends to hold the man.

There is a certain process of thought and feeling which the new man usually passes through in tackling a new job. The first is that of being out of place, of strangeness of surroundings; the second is that of adjustment; the third is a comsummation which determines whether he shall stay or quit. The instructors trained by the Emergency Fleet Corporation are taught to keep a sharp lookout for these processes of thought in the new man. By a little effort the instructor can eliminate the feeling of strangeness. Care in choosing the surroundings and in instructing the new man will greatly help him to adjust himself. The determination as to whether a man shall stay or quit is largely a matter of interest and depends on how well he can do the new job and the consciousness that when he is turned over to the production department he can at least "hold up his own end" as well as the other fellow.

These considerations and the elimination of high overhead costs caused by the old methods of training, spoiled work, wasted time by the learner, time spent in teaching by the tradesman, etc., probably make the training of new men by a trained instructor whose job it is to do nothing but instruct, the cheapest method that has yet been evolved for the training of shipyard workers.

[Note.—Correspondence on the subject of the training of instructors is invited by the Emergency Fleet Corporation; communications should be sent to Mr. E. E. McNary, director of training, Emergency Fleet Corporation, 136 South Sixteenth street, Philadelphia, Pa.]

Full-Powered Motorship Alabama, of 3,600 Tons D. W., Completed on Pacific Coast

The Alaska Pacific Construction Company, Seattle, Wash., has recently built a full-powered motorship designed by E. B. Schock, naval architect, Seattle, which is 270 feet 6 inches long overall, 256 feet 6 inches on the waterline, 46 feet beam and 26 feet 6 inches molded depth, with a deadweight carrying capacity of 3,600 tons. The vessel is of the full two-deck type freighter, with machinery aft and a full open hold for the carrying of lumber. She is built throughout of Douglas fir and was given highest class rating by the Bureau Veritas.

Wooden Motorship *Alabama* on the Ways at Yard of Alaska Pacific Construction Company

Propulsion is by twin screws actuated by six-cylinder, 625 indicated horsepower McIntosh-Seymour Diesel engines. There is a fuel capacity for a 9,000-mile cruising radius. Auxiliary power for winches, etc., are supplied by a Y-type, 75-horsepower, two-cylinder Fairbanks-Morse stationary oil engine, which also drives a generator for furnishing electricity for heating, as well as for the winches and windlass.

The cargo is handled through two large hatches, 16 feet by 24 feet, fitted with four cargo booms, each 55 feet long. The vessel was launched on April 24 and christened the *Alabama.*

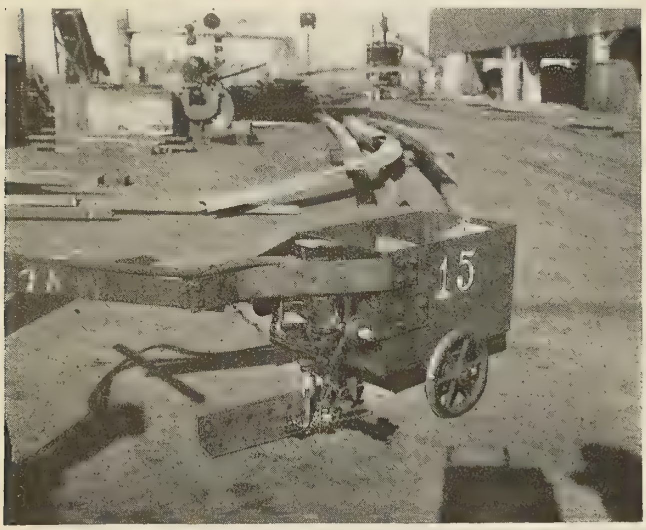
Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Pneumatic Drill Adapted as a Portable Countersinking Machine

The accompanying illustrations show very clearly the way in which a No. 1-B "Little David" drill has been



Improvised Portable Countersinking Machine

rigged up by the Hanlon Drydock and Shipbuilding Company, Oakland, California, for service as a portable countersinking machine. The drill has been fastened to two metal supports bolted to the sides of an iron box 16 inches wide, 24 inches long and 16 inches high, provided with a suitable stop for the feed screw. The rig is fitted with a 6-foot handle and mounted on two wheels. Sufficient weight is placed on the box to give the outfit proper stability when in operation. An air hose is connected and a valve placed in the line for use instead of the usual drill throttle. A second hose is provided to feed water for cooling the countersink. Mr. Hiefield, the superintendent, is authority for the statement that this rig will do from 75 to 100 percent more work than the stationary wall countersinkers.

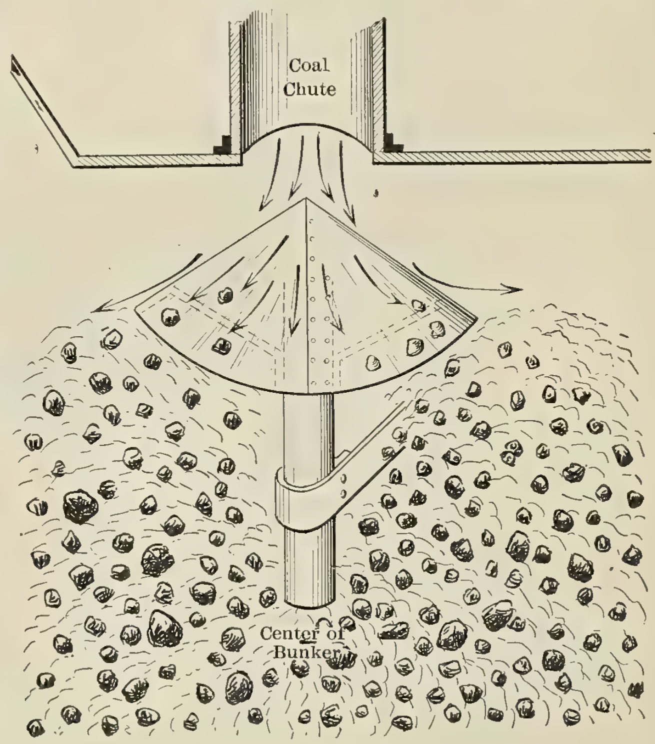
Countersinking Machine in Operation

An outfit of this kind can be easily constructed in any shop and represents but a moderate investment. A suggested modification is that the box be partitioned through the center and that counterweights be carried in the compartment farthest from the drill; and the other half of the box be used as a tank to carry water for cooling the countersink. This would obviate the necessity of a double hose connections.

New York. H. L. Hicks.

Bunker Coal Spreader

Perhaps some of the naval architects or ship designers who cast their optics upon this little affair will laugh and snicker and wonder what fool thought of such an idea,



Sketch of Device for Spreading Coal in Bunker

but nevertheless I can vouch for its practicability as a labor saver in stowing bunkers of a certain vessel. The sketch gives the idea of how the thing works.

On the steamer ——— we had three 100-ton bunkers with their coaling trunks or chutes located right in the center. When coaling ship, the coal would shoot merrily into these bunkers until there would be formed a conical pile right up to the chute, which would then choke up.

The firemen and coal heavers would then be busy every minute stowing from the chute to the corners and sides. From the time the chutes choked till the bunker would be stowed full, 40 tons had to be handled in each bunker.

One day the engineer in charge of the firerooms and coal bunkers hit upon the scheme of making a stout steel, conical-shaped spreader to be installed directly under the center of the chute with plenty of clearance to prevent its blocking by large lumps of coal. He obtained permission from the chief to make one and try it out.

Procuring a spare piece of ⅝-inch boiler plate and the boiler maker's help he got one rigged up, and when the next coaling ship came around he anxiously awaited the results.

It worked quite well, but did not fully come up to expectations. It gave a clear run of 85 tons—25 more tons than when no spreader was used. The bottom diameter of the cone was 4½ feet; the diameter of the coal chute was 2 feet 6 inches. The coal had to drop through 20 feet to the chute, and when it hit the spreader it would shoot clear to the corners of the bunker; it also broke up a large percentage of the lumps. C. H. Willey.

Bushing Kinks

There are hundreds of bushings used in the machinery on board ship, pump rocker arms, reach rods, governor spindles, valve stem brackets or guides, ice machinery rods, etc., and these are always calling for attention, so these

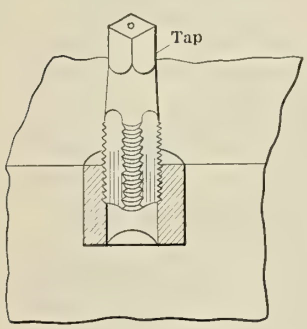


Fig. 1

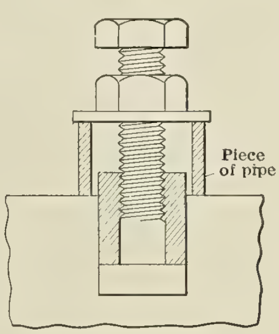


Fig. 2

few kinks that the writer has picked up in his time may be of some benefit to others.

For removing a wornout bushing that is accessible from one side only, the scheme shown in Figs. 1 and 2 is used. When the bushing is small and can be threaded, the tap is used to cut half a dozen good threads, then a bit of pipe, a bolt, nut and washer are used, as in Fig. 2, to

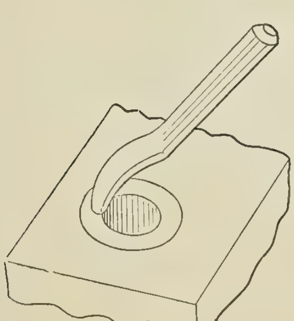


Fig. 3

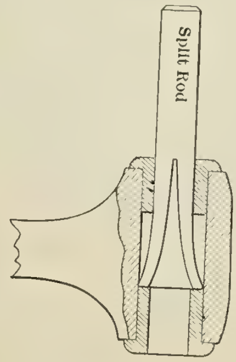


Fig. 4

draw out the bushing. When the bushing is too large for a tap and is worn out so that it is of no further use, it is cut out with a round nose grooving chisel as in Fig. 3.

When you meet up with flanged bushings installed as shown in the sketch, Fig. 4, a very simple but excellent way to drive them out is to make the two tools shown in Figs. 5 and 6. A round piece of stock that is of the same diameter as the hole in the bushing is all that is needed.

Grind one piece into a wedge at one end, as in Fig. 5, and with a hack saw split one end of the other piece.

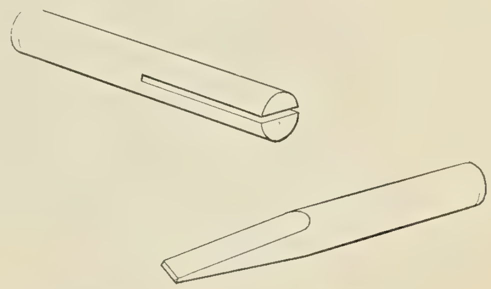


Fig. 6 Fig. 5

Enter the split piece through one bushing, and while holding it enter the wedge piece in the other bushing by forcing the wedge into the split; that piece is opened out as indicated in Fig. 4, so that the ends bear against the inside edge of the bushing, which can then be driven out.

For forcing small bushing into rods, etc., the bench vise can be very easily used to good advantage, as shown in Fig. 7. When one uses a vise for this purpose the screw of it should be well oiled; it should also be borne in mind that undue leverage should be avoided. A short piece of pipe, say 1 foot, is sufficient to distort a vise screw when used on the handle with brute strength and lack of judgment.

Where long bushings are to be installed, such as shown in Fig. 8, a long, threaded bolt nut and suitable washers

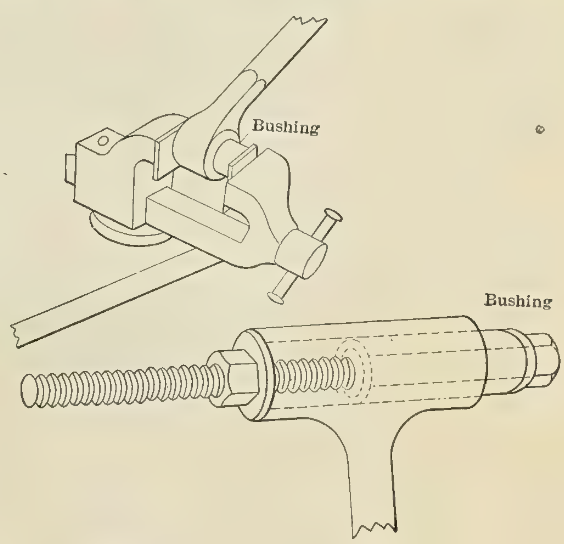


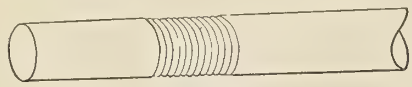
Fig. 7 Fig. 8

answer the purpose and do a better job than driving in with a hammer and block of wood, for the bushing will go in square.

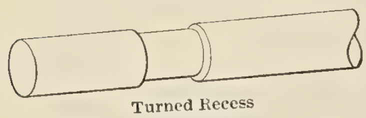
Figs. 10, 11, 12 and 13 show how a loose pulley on a countershaft in the ship's machine shop was bushed. The shaft had become worn and scored so that it was really necessary to turn it. The sketches in series are self-explanatory. The shaft was recessed; the least amount was taken off of both just enough to true them up; then a bush-

ing was made, the inside bored to fit the recessed part of the shaft; this was then perforated with oil holes and split in two halves, the burrs trimmed off and the two pieces put in place, as in Fig. 12. The pulley was slipped on and the thrust collars put on; then the job was complete and ran satisfactorily.

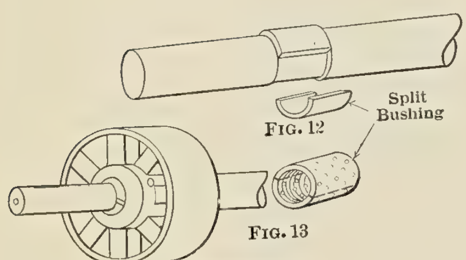
Quite often a bushing such as used in valve rods, etc., will become worn so that it rattles or knocks, yet the bushing is far from being worn out. There are a couple



Worn Shaft
Fig. 10



Turned Recess
Fig. 11



Replace Pulley

Figs. 10 to 13

of ways to get more service out of such bushings. One is to take the bushing out and give it a heavy coating of solder inside, then ream it to fit the pin. This is called tinning the bushing, and is O. K. where there is a slight clicking or rattle and the pin is true.

The second way to take up wear is shown in Fig. 14. The bushing is taken out and a slot is cut through it with

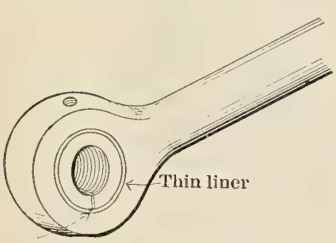
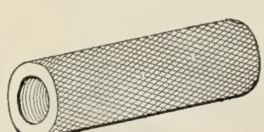


Fig. 14



Cross knurled

Fig. 15

a hack saw; then a thin liner of brass or tin is wrapped around the outside of the bushing and the two are forced back into the rod. This closes the bushing in making the two edges of the slot come flush. The hole is now eccentric and will have to be carefully reamed with a reamer the size of the pin that works in the bushing. Don't forget to drill an oil hole in the liner.

Sometimes a bushing works loose and revolves around in the hole. This allows the oil hole in the bushing to get out of place or blanked off, which will cause rapid wear of the bushing. A cure for loose bushings is to take them out and with a prick punch burr them up all around the outside; then re-drive them. But a better job is to make them larger in diameter by knurling them with a coarse knurl, as shown in Fig. 15. This required putting the bushing on an arbor in the lathe. The writer has cured many troublesome small and large bushings in this way

C. H. Willey.

Mercantile Marine Uniforms

For many years the question of a standard and approved uniform for the mercantile marine has exercised the minds of most of its officers. The trouble has been that recognition was denied to rank and competence; and even a master mariner, to say nothing of a chief engineer, had no official right to bear badge or mark of rank. Custom conceded the usage, but there was no right to use, and, although there existed a certain similarity, each company had its own regulations, the badge generally being the house flag of the ship owner.

The practice led to confusion, to the open contempt of commissioned officers of the combatant navy for the officers of the mercantile marine. Indeed, cases of insult and degradation have not been unknown, and the most junior officer of the combatant service considered himself superior and took precedence of the most experienced officer of a large passenger or mail vessel.

The mercantile marine has been the Cinderella sea service, existing by favor, struggling under adversity, of no national importance, and its most capable members enjoyed no recognition, and very few, if any, rights. The war has, however, placed the mercantile marine in the position, if not of combatants, at least in the post of danger, which is also the post of honor. Sacrifices of great magnitude have been met in the spirit of the true tradition of the sea. Without flinching, with contempt for realized danger, and without the protection which armorplate and big guns afford, the cargo tramp, liner and mail packet have been undeterred. In spite of sinking, mishap and sudden death, there has never yet been any difficulty in finding officers and crew to man the commercial navy.

Recognition has come slowly, but it has come at last. In the same way as the combatant navy, the mercantile marine is to have a standard, universal and acknowledged uniform, with badges of rank and lawful recognition.

A committee with powers of decision representing the Board of Trade, the Admiralty, the Chamber of Shipping of the United Kingdom, the Liverpool Steamship Owners' Association, the Mercantile Marine Service Association, the Imperial Merchant Service Guild and the Marine Engineers' Association, have deliberated ten months on the matter, and a decision has been reached. This matter of a national and authorized uniform has been demanded by the merchant service for years past.

Numerous cases have arisen in which indignity and humiliation have been suffered by merchant service officers, due to their uniforms resembling too closely those of the navy. Now all this is at an end. It has been decided, moreover, that the new uniform may only be worn by certificated officers, and it will differ from the uniforms of the combatant service.

The cap badge will not bear the shipowner's flag; it is considered that the primary function is to distinguish a member of the crew as an officer—not to advertise the company. This proposal met with opposition from many shipowners, but the weight of evidence and the intrinsic importance of the matter carried the day.

The new uniform and the committee's proposals now only await governmental sanction, and absolute details are yet to come. It is, however, certain that the mercantile marine now enter on a new stage of existence, being recognized as a national service, and not merely and simply as an unfortunate necessity.

Recognition involved by certificates of competency and a national and universal uniform, possess disciplinary

powers and give the wearer a real distinction in the scheme of marine matters. It will remove the man involved from the shipowner's sphere of influence and give him a new self-respect founded on valid grounds.

In all respects, the decision is to be applauded, and it is to be hoped that in marking the distinction between the combatant and merchant navies care will be taken that the new official uniform shall at least be reasonable and not conspicuous in a derogatory sense. So far as is known, the cap badge will be a plain anchor surrounded by oak leaves—that is, it will be distinct from the British navy by the omission of the crown.

There is no earthly reason why the proposal should not have been carried into effect decades ago; but now that it has come, a real point of cardinal importance has been gained. The recognition of the engineer is proceeding apace in all quarters, and in common with the navigating officers the engineers of the merchant marine are now to be recognized.

A. L. Haas.

NEW BOOKS

Submarines: A List of References in the New York Public Library. Compiled by Mary Ethel Jameson, Science Division; with a foreword by Simon Lake. Size, 7 by 10 inches. Pages, 97. New York, 1918: New York Public Library.

This list was compiled as an aid to those interested in the history and construction of the submarine boat. It covers published articles on this subject dating back to a period of over two thousand years to the present time, and includes references on submarine signalling.

Hiring the Worker. By Roy Willmarth Kelly. Size, 5½ by 8½ inches. Pages, 250; numerous illustrations. New York, 1918: The Engineering Magazine Company. Price, $2.00.

Because of the rapid development and constantly changing ideals of the employment management movement, superintendents, foreman and managers are constantly faced with new problems in securing and keeping employees. This book gives especially pertinent information regarding the vital problem of selection and the gradual education of employees and also regarding the reduction of labor turnover.

Record of American and Foreign Shipping. Size, 9 by 9¼ inches. Pages, 1,056. New York, 1918: American Bureau of Shipping. Price, $20.00.

American Bureau of Shipping, Great Lakes Department. Size, 12 by 8 inches. New York, 1918: American Bureau of Shipping. Price, $25.00.

The two volumes published by the American Bureau of Shipping contain a complete record of American and foreign vessels in ocean and lake service. Tabulated details of the vessels form the bulk of these annual volumes, but supplementary lists are given in both books of names and addresses of vessel owners, shipbuilders and underwriters. For convenience, lists are also given of vessels with compound names and vessels whose names have been changed.

General List of Merchant Shipping (two volumes). Volume I, Steamers and Motor Vessels. Size, 10½ by 11 inches. Pages, 1,300. Volume II, Sailing Vessels. Size, 10½ by 11 inches. Pages, 850. Paris, 1918: Bureau Veritas. Price, complete, £3 10s. Separate volumes, steamers, £2; sailing vessels, £1 15s.

This work, published in two volumes, one for sailing vessels, the other for steamers, has been issued annually since 1870. It contains a complete list of all merchant vessels in the world above 50 tons gross for sailing vessels and above 100 tons gross for steamers. It gives particulars regarding the construction, type, ownership, method of propulsion, port of registry, etc., of each vessel, besides lists of shipowners, shipbuilders and dry docks.

Manual for the Guidance of Apprentices on Training Ships. Size, 4¼ by 6 inches. Pages, 215; numerous illustrations. Boston, 1918: Sea Training Bureau, Recruiting Service, United States Shipping Board.

Due to the large number of inexperienced men being taken into the merchant marine service this year to man the emergency fleet, strenuous efforts are being made to train these men in the shortest possible time for the work they are called upon to do. To aid in this work, this Manual has been prepared for the guidance and instruction of apprentices on the training ships of the United States Shipping Board and contains general information regarding deck and engine room service that will be found helpful while the apprentice is in training and later on when he is assigned to vessels of the merchant marine.

Electric Welding Manual. Size, 5¾ by 9 inches. Pages, 46; numerous illustrations. New York, 1918: Wilson Welder & Metals Company, Inc. Price, $1.00.

Since the wonderful record was made last year in repairing the damaged machinery of German vessels taken over by the United States Government, largely by means of Wilson electric welding equipment, great interest has been aroused in the possibilities of electric welding for all kinds of ship repair and construction work. To further the development of this class of work, this manual has been compiled, giving instruction covering the installation, care, operation and maintenance of the Wilson type of electric welding equipment. Directions are also given to be followed in welding various kinds of metal, specifying the grade of welding wire to be used, the amount of current or heat values to employ, with other useful information for the engineer, foreman or welder. The apparatus and its application are thoroughly illustrated.

Safeguarding the Gateways of Alaska and Her Waterways. By E. Lester Jones, Superintendent, United States Coast and Geodetic Survey, Department of Commerce. Size, 8 by 10½ inches. Pages, 41. Illustrations, 50. Washington, 1918: Government Printing Office.

Alaska, with its more than 26,000 miles of coast line, cannot be approached without traversing the waters that nearly surround it; the only means to get to the seaport towns and the interior is by ships. For the proper development of Alaska, it is, therefore, imperative that these vast water areas be protected by the most careful survey in locating hidden dangers. The toll in wrecks in Alaskan waters during the past fifty years has been tremendous. To overcome these dangers, the author makes an urgent plea for immediate authorization of new vessels and launches for carrying out a complete survey of Alaskan waters by the Coast and Geodetic Survey.

A Naval Engagement: A Marine Narrative of Love and War. By Elbridge Gerry Roberts. Size, 5 by 7⅜ inches. Pages, 240. Red Bank, N. J., 1918: Elbridge Gerry Roberts. Price, $1.25.

Just at a time when the patriotism of true Americans is stirred to the utmost by the part our country is playing in the greatest conflict the world has ever known, it is heartening to read from the pen of a new author a vigorous story of heroic deeds and chivalry in Civil War days. Lovers of the sea and adventure will find in Mr. Roberts' narrative a delightful tale of heroism and romance, not all of which, we suspect, is entirely fiction, as the author's father, to whom the book is dedicated, rendered services to his country during the Civil War period for which the country made public acknowledgment and rendered suitable recognition and which might well form the basis of such a story.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number if from examination for grade of chief, and by a dagger (†) if from examination for other grades.

Design of Eye Pad and Shackle

Q. (964).—(1) What is the proper safe load, using 12,000 pounds per square inch as the safe fiber stress, on the pad eye (Fig. 1), and how do you determine this safe load? What would be the moment of inertia at "*A-A*" about axes 1-1 and 2-2?

(2) Design a shackle as shown in Fig. 2 capable of handling safely 75 gross tons, using a safe fibre stress, as above.

(3) Have you, or can you refer me to, any book containing data on the rolling of ships in still water other than that contained in such books as White's, Peabody's and Attwood's? Recently it was desired to know what was a safe period of roll for several ships that had been taken over by this Government for which we had no G. M., radius of gyration, or curves of any kind. Was it possible to obtain these data approximately by knowing the length, breadth and depth? Or, if the displacement and other curves had been available, would it have been possible to determine the period of roll that would give a safe G. M.?

A. (964).—1. The axes 1-1 and 2-2 are the same line as shown on the sketch, and the moment of inertia would be

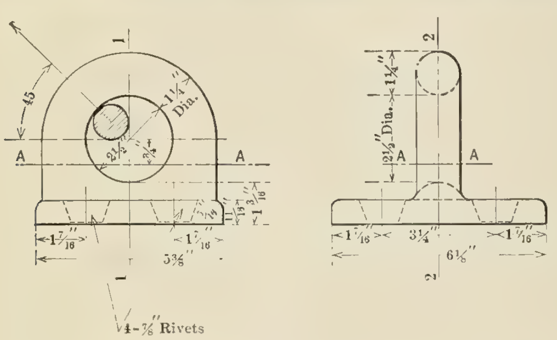


Fig. 1

the polar moment of inertia of the section *A-A*. Probably what is wanted is the moment of inertia about an axis perpendicular to 1-1 and also about one perpendicular to 2-2, which would be the ordinary longitudinal and transverse moments of inertia. These could be obtained with fair approximation as follows: Assume that the section at *A-A* consisted of four semi-circles, each pair separated by a rectangle, so that the total distance across each figure is equal to the distance shown on the sketch. Then for the longitudinal moment of inertia,

I for semi-circle about its $C\,G = 0.00685\,D^4$.

(A) I_{cg} for most remote semi-circle $= 0.00687 \times$

$$\left(\frac{5}{4}\right)^4 = 0.0169.$$

(C) I_{cg} for inner semi-circle $= 0.00687 \times$

$$\left(\frac{5}{4}\right)^4 = 0.0169.$$

(B) I_{cg} for rectangle is $\dfrac{b\,d^3}{12} = \dfrac{5}{4} \times \left(\dfrac{1}{4}\right)^3 \times \dfrac{1}{12} = 0.0016.$

These are all about the centers of gravity of each figure, and must be transferred to the center of gravity of the whole section by the relation $I = I + X^2$ area,

$$I \text{ of } A \text{ area} = 0.0169 + 0.613 \times \overline{1.36}^2 = 1.150$$

$$I \text{ of } B \text{ area} = 0.0016 + 0.312 \times \left(\frac{7}{4}\right)^2 = 0.966$$

$$I \text{ of } C \text{ area} = 0.0169 + 0.613 \times (2.14)^2 = 2.827$$

For one-half section total $= 4.943$
And for total section $I = 9.886$ in.^{4}

The transverse moment of inertia (about axis perpendicular to 2-2) is that of two circles $1\frac{1}{4}$ inches diameter and 2 rectangles $1\frac{1}{4}$ inches $\times \frac{1}{4}$ inch.

$$I \text{ of circle about diameter} = 0.049\,D^4 = 0.1198 \text{ in.}^4$$

$$I \text{ of rectangle} = \frac{b\,d^3}{12} = \frac{1}{4}\left(\frac{5/4^3}{12}\right) = 0.0407 \text{ in.}^4$$

$$\text{Total} = 0.1198 + 0.0407 = 0.1605.$$

and for whole section is

$$2 \times 0.1605 = 0.321 \text{ in.}^4$$

If the line of action of the force always is in the direction indicated, then the pad eye is improperly designed, as

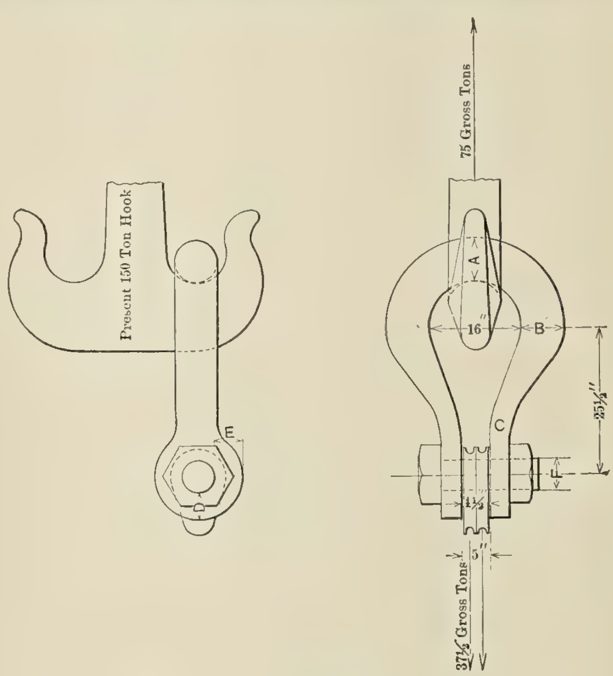


Fig. 2

it should be symmetrical about the line of action of the force. Confining ourselves, however, to this specific problem as given, the weakest section would probably be through the centerline of the eye. If we take a section normal to the force, the stress would be approximately the load divided by the area of the section. If we assume

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

fracture is to take place across a horizontal section through the center of the eye, the following computation may be made:

The tension due to the vertical component of the force is

$$\text{Force} \times \text{Sine } 45^\circ = P \times 0.707.$$

This is distributed over an area of 2.45 square inches, so that the direct stress is

$$f_t = \frac{0.707\,P}{2.45} = 0.289\,P.$$

Similarly, the shearing stress is $f_s = 0.289\,P$.

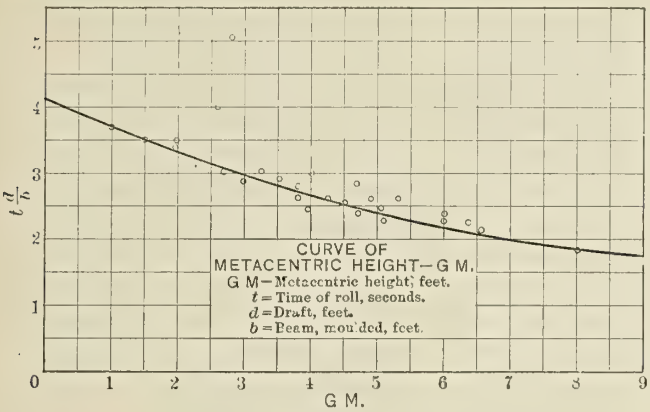


Fig. 3

Combining these by Rankine's expression

$$f = \frac{1}{2} f_s + \tfrac{1}{2}\sqrt{f_s^2 + 4 f_t^2}.$$

$$\text{We get } f = \frac{0.289}{2} P + \tfrac{1}{2}\sqrt{(0.289\,P)^2 + 4\,(0.289\,P)^2}$$

$$= 0.467\ P,$$

and if we limit f to 12,000 pounds

$$P = \frac{12{,}000}{0.467} = 25{,}700 \text{ pounds.}$$

This neglects the link action of the eye, and so probably overestimates the load it would carry, but space here is too limited to take account of that.

2.—Assuming the pin to bear shearing stress only, the diameter F will be determined as follows:

It has to bear a single shear of 37½ tons, or 84,000 pounds. If the allowance fiber stress in tension is 12,000 pounds per square inch, the allowable fiber stress in shear will be about ½, or 6,000 pounds.

The required area will be

$$\frac{84{,}000}{6{,}000} = 14 \text{ square inches.}$$

Diameter = 4¼ inches approximately = F.

For the dimensions E and C there will be four rectangular areas ($E \times C$) to bear 168,000 pounds in direct tension. The area of each will then be

$$\frac{168{,}000}{4 \times 12{,}000} = 3\tfrac{1}{2} \text{ square inches.}$$

E and C dimensions are to be selected to give this area. Make D = to E.

The solution for A and B should properly be by the link theory, and is too involved to be given here. Experiments by Goodenough and Moore (Bulletin No. 18, University of Illinois) give the following for an open link chain, and this might be applied to this case with reasonable accuracy.

$P = 0.4\,d^2\,S$, where
P = safe load on link in pounds,
d = diameter of bar from which chain is made,
S = maximum permissible intensity of stress.

For our case this becomes

$$75 \times 2{,}240 = 0.4\,d^2 \times 12{,}000,$$
$$d^2 = 35,$$
$$d = 6 \text{ inches, approximately.}$$

It is worth noting, however, that 12,000 pounds is rather high for an allowable fiber stress for a unit of this sort, which may be subject to shocks.

3. There is something on metacentric height and rolling in "The Design and Construction of Ships," by J. H. Biles. Some time ago I plotted all the data I could find on time of rolling and metacentric height, and drew the curve in Fig. 3, but have not been able to get much recent data to add to it. I give it for what it may be worth, but do not advise placing much reliance upon it. The "time of roll" is the time the ship takes to roll from extreme starboard position to extreme port (one-half the mathematical time for one vibration).

Tonnage of Vessels

Q. (967).—I would like to have you publish information regarding the different tonnage and weights of vessels to which reference is constantly being made in different newspapers, such as gross tonnage, net tonnage, displacement and deadweight. I would also like to know how the constant is obtained and how applied to find the weight of a ship when docking?

A. (967).—A ton is really a measure of weight, and legally is 2,240 pounds. But in ship work, on account of the varied bulk of the material dealt with and the desire to rate cargoes, etc., on a weight basis when only the volumetric capacity was known, there were evolved various volumetric equivalents, such as 44 cubic feet = 1 ton, for coal; 35 cubic feet = 1 ton, for sea water, etc., and later it was proposed to accept 100 cubic feet as the equivalent of 1 ton of general merchandise. The tonnage given on certificates of registration, legal documents, etc., is generally called registered tonnage, and simply means the cubical contents of the vessel divided by 100, and has no bearing whatsoever upon the *weight of the vessel and cargo,* which is *displacement.* The registered tonnage has three forms: Gross, net and underdeck, all depending upon the spaces included in the measurement.

For example, underdeck tonnage comprises all space below the tonnage deck; gross tonnage is "all spaces below the upper deck, as well as permanently closed in spaces on that deck;" and net tonnage is gross tonnage less certain allowed deductions, supposed not to be available for carrying cargo. These are all simply cubical contents divided by 100, on the basis of 100 cubic feet = 1 ton.

Displacement (sometimes called displacement tonnage) is the actual weight in tons (2,240 pounds) the ship displaces when floating at the draft under consideration. It is a true weight measurement and is divided by figuring the volume of the submerged body of the ship and dividing by 35, on the basis of 35 cubic feet sea water = 1 ton.

Deadweight, or deadweight tonnage, is the carrying capacity of the ship in actual tons of 2,240 pounds, and is the difference in displacement of the ship light, but with stores and fuel, and loaded, but with the same stores and fuel.

As registered tonnage was evolved to obtain a fair estimate for the payment of port charges and taxes, only commercial craft use it. When war vessels use facilities for which they have to pay, their rate is determined usually upon their *displacement,* as they have no registered tonnage, and this has given rise to the use of the word "displacement-tonnage," which is really a misnomer.

Shipbuilding and General Marine News

**Contracts for New Ships—Shipyard Improvements—
Engineering Projects—Improved Appliances—Personal Items**

NAVAL BOARD REJECTS BUOYANCY BOX DEVICE

Donnelly System Considered Impracticable for General Use

The board appointed by Secretary Daniels to report on the Donnelly system of buoyancy boxes as installed on the steamship *Lucia* has reported that the *Lucia* installation is not advisable for general adoption under existing conditions by reason of—

(1) The questionable efficacy as a preventive against sinking;

(2) The reduction in cargo-carrying capacity, both deadweight and cubic contents, and

(3) The length of time required for installation.

No Actual Torpedo Test

Although the vessel was not subjected to actual test by the explosion of a torpedo against her side, calculations were made by the board based on results of damage actually received by vessels that had been torpedoed, and it was found that the *Lucia* would, after the explosion, be little better than a water-logged derelict, and, under these conditions, even should she remain afloat, her salvage would prove difficult.

The board points out that while there is no doubt that buoyancy boxes could be installed in sufficient numbers and so located that they would not endanger the stability of a vessel, this can be done only by a loss in actual deadweight capacity of the vessel equal to the weight of the boxes installed, and also a reduction in the cubical capacity of the holds.

Time Requirement Considered

As regards the time required for making an installation of this type on other vessels, the board states that this is a matter of vital importance, as the laying up altogether, or in succession, of a large number of ships for any considerable length of time is not considered permissible in view of the present shipping situation. Mr. Donnelly claims that one week would be sufficient time to install the *Lucia* type of boxes in a vessel. The board gives its opinion that this claim is impossible of accomplishment on account of the large number of boxes involved—12,000 in the case of the *Lucia*—and the wharf and storehouse space that would be required for boxes before they could be installed, which, under existing conditions of congested freight terminals, is impossible to obtain.

Report on Other Methods

In addition to reporting on the installation on the *Lucia,* Secretary Daniels directed the board to investigate and report upon the value and practicability of other means of preserving buoyancy of vessels in war service. In complying with these instructions, the board reported:

(a) That external protection by any means so far suggested is not a practicable solution of the problem of preserving buoyancy, by reason of the reduction in speed and the difficulties in attaching or operating such features.

(b) That attached methods of buoyancy protection by "bulges" and "blisters" are objectionable on account of the reduction in speed and the difficulty in fitting this form of protection.

(c) No form of buoyancy box or any so far suggested material for stuffing affords a practicable solution of the buoyancy problem, on account of the reduction in deadweight and cubic capacity, etc.

(d) A judicious selection of cargo will aid materially in obtaining better buoyancy conditions in the case of damage resulting from flooding of holds.

(e) Internal protection by subdividing bulkheads is the best way to preserve buoyancy of vessels operating in the war zone.

COST PLUS CONTRACTS AT NEWARK SHIPYARD ANNULLED

Price of $960,000 Placed on Vessels Built by Submarine Boat Corporation

Charles M. Schwab, director general of the Emergency Fleet Corporation, has cancelled the cost plus fee contracts of the Submarine Boat Corporation, operating the Newark Government plant, substituting a flat rate whereby the builders will receive $960,000 for each complete 5,000-ton cargo ship.

The original contract with the Submarine Boat Corporation was in all respects similar to cost plus contracts with the other Government yards. The substitution of the new flat rate contract at the Newark Yard is therefore an experiment.

Marine Terminal Projects

The War Department, Washington, D. C., is reported to have decided to spend more than $15,000,000 in establishing a Government shipping station near Baltimore, Md.

The War Department, Washington, D. C., through Major J. L. Lee, Charleston, S. C., will spent $20,000,000 to build piers and warehouses for the quartermaster's department.

The Seaboard Transportation & Shipping Company, Dallas, Tex., is planning to build a wharf.

The Nova Scotia Construction Company, Metropole Building, Halifax, Nova Scotia, has received a contract from the Canadian Department of Marine and Fisheries to build a wharf and pier.

NAVAL APPROPRIATION BILL NOW CALLS FOR $1,610,000,000

Senate Adds $226,000,000 to House Bill

With scarcely any delay, the Naval Appropriation bill passed the Senate without roll call on May 22, carrying $1,610,000,000. The measure, increased by about $226,000,000 over the House authorization, immediately went to conference.

Construction of superdreadnaughts and battle cruisers, provided for in 1916, have been temporarily held up to give way for the building of destroyers. The present bill proposes starting work on each of the more than 150 ships provided for in the three-year programme.

Numerous new projects and extensions at the navy yards and naval stations are provided for in the bill, as well as additional amounts for ordnance and ammunition.

Shipbuilding Contracts

The American International Shipbuilding Corporation, 120 Broadway, New York, Walter Goodenough, general manager, Bellevue-Stratford Hotel, Philadelphia, Pa., which operates the Hog Island shipyard, has received a contract from the United States Shipping Board to build sixty additional steel ships. It is reported that the Hog Island plant now has orders to build 180 ships.

The Redwood City Shipbuilding Company, Redwood City, Cal., has received a contract to build ten concrete ships for the United States Shipping Board.

The yard of the former Samuel L. Moore & Sons Corporation, Elizabethport, N. J., now operated by the Bethlehem Shipbuilding Corporation, is building two 3,500-ton freight ships and a 5,000-ton steel tank steamship.

The Northwest Steel Company, Portland, Ore., J. R. Bowles, president, has received a contract from the United States Shipping Board to build four more 8,800-ton steel steamships.

The American Shipbuilding Company, W. W. Johnston, purchasing agent, Cleveland, Ohio, has received a contract from the United States Shipping Board to build sixty-six ships of Welland Canal size, 261 feet in length. The tonnage of sixty of these will be 4,200 and of the other six, 3,500.

J. F. Duthie & Company, E. C. Gaumnitz, purchasing agent, Seattle, Wash., has received a contract from the United States Shipping Board to build ten 8,800-ton steel ships. The Duthie plant will make improvements and additions at a cost of more than $200,000.

The Liberty Shipbuilding Company, Brunswick, Ga., is reported to have received a contract from the United States Shipping Board to build a large num-

ber of steel steamships. Max Schoolman, Brunswick, is general manager.

The Carolina Shipbuilding Company, which is a subsidiary of the George A. Fuller Company, 175 Fifth avenue, New York, will build a yard at Wilmington, N. C., and is reported to have received a contract from the United States Shipping Board, to build eighteen 9,600-ton steel steamships of the Isherwood type.

The Jarrett Shipbuilding Company, Superior, Wis., has an order to build ten 3,500-ton ships for the United States Shipping Board, and two trawlers for the Bay State Fishing Company, Boston, Mass.

Hans Pederson, Seattle, Wash., is the head of the recently incorporated Pederson Shipbuilding Company, which is reported to have received a contract to build eight ships of 3,500 tons capacity for the French government.

The Ambursen Construction Company, 61 Broadway, New York, S. W. Stewart, president, has received a contract from the Bureau of Construction & Repair, Navy Department, Washington, D. C., to build four reinforced concrete fuel oil and coal barges to be used in New York Harbor. These vessels are designed to carry 800 tons of fuel oil and the same tonnage of coal or other cargo. They will be built at the Ambursen Construction Company's yard on the Hackensack River.

The Concrete Shipbuilding Company has opened an office at 260 Stark street, Portland, Me., and plans to build concrete barges and cargo vessels.

F. S. Bowker, Phippsburg, Me., has an order to build a four-masted wooden schooner.

The Taylor Engineering Company, Vancouver, B. C., has received a contract to build a dry dock near Vancouver, to cost $750,000. The plans will be drawn by W. T. Donnelly, 17 Battery Place, New York.

The Fernandina Ship Building & Dry Dock Company, Fernandina, Fla., has received a contract from the United States Shipping Board to build twelve steel sea-going tugs. The contract price is stated to be $3,000,000. This company has a thirty-acre site with 1,200 feet of waterfront, and is planning a complete shipyard to build steel vessels up to 8,000 tons capacity.

Portland Shipbuilding Records

Portland has completed a steel steamship, 8,800 tons deadweight, in 83 working days, establishing a new record. The new vessel was the *Westgrove*, which left the dock of the Columbia River Shipbuilding Corporation at 8:30 o'clock Tuesday morning, April 23, to go to a berth to load a ballast cargo for her trial trip.

The keel of the vessel was started January 15 and the hull launched March 27, and James McKinlay, general manager of the plant, said the time was 83 working days. That lowers the best previous time by 10 days, Skinner & Eddy, of Seattle, having finished a ship of the same size in 93 days.

Then Portland has the record for the fastest wooden ship construction, which was gained by the Grant Smith-Porter Ship Company when the hull of the *Wakan* was floated. An official message to the Washington headquarters of the Emergency Fleet Corporation is that the work was done in 52 working days. The keel was laid February 19.

SHIPBUILDING AND SHIPPING ON THE GREAT LAKES

Lake Yards to Add a Million Tons to the Output Next Year—Lake Production Practically All for Salt Water Service

BY F. H. GRISWOLD

At a conference in Cleveland on May 20 with Charles M. Schwab, director general, and Charles Piez, vice-president, of the Emergency Fleet Corporation, representatives of the Great Lakes shipbuilding companies were assured of contracts totaling about $100,000,000, comprising 130 vessels to cost approximately $800,000 each. The ships will be of 4,200 tons deadweight carrying capacity and of 1,500 horsepower. They will be of full Welland canal size, with a depth of over 28 feet. Deliveries are to be completed by the end of the Lake shipping season in 1919.

The order will be apportioned among the following firms: American Ship Building Company, 60; Great Lakes Engineering Company, Detroit, 24; Manitowoc Shipbuilding Company, Manitowoc, Wis., 12. The rest will be divided among the Toledo Shipbuilding Company, Toledo, the McDougall-Duluth Shipbuilding Company and the Globe Shipbuilding Company, of Duluth.

Extensions of the existing yards, which will be necessary to handle the new programme, will be begun immediately.

3,500-Ton Ships

While in Chicago on May 15, Charles Piez, vice-president of the Emergency Fleet Corporation, stated that 440 wooden ships of 3,500 tons each will be completed in yards on the Atlantic and Pacific coasts, and 125 steel ships of 3,500 tons each will be completed on the Great Lakes by February 1, 1919. The total tonnage of these vessels will be close to 2,000,000. This is exclusive of the larger ships.

Forty wooden ships, declared Mr. Piez, have been launched and will be ready within a month. These are of the Hough type of 3,500 tons each, driven by twin screws. Most of the vessels under construction on the Lakes are of varying types, as the builders are permitted to follow their own methods within certain limits.

Concrete Ships

A considerable number of concrete ships will be built, according to Mr. Piez, including two 3,500-ton steamers and six 7,500-ton tankers. A four-way yard at San Francisco has been authorized for this purpose. The location was chosen largely on account of the climate, so that there will be no interruption in the work of pouring concrete because of frost.

Plan for Building 6,200-Ton Ocean-Going Cargo Vessels on the Great Lakes Feasible, says Hurley

Edward N. Hurley, chairman of the Shipping Board, who was in Chicago recently, confirmed the report that the new plan for building ocean-going cargo vessels of 6,200 tons deadweight carrying capacity on the Great Lakes is being worked out satisfactorily.

According to this plan, both the hull and machinery of the vessels will be fabricated complete on the Great Lakes. The vessel will then proceed through the locks to the St. Lawrence River in abbreviated form. All of the material for completing the vessel will be carried on board to tide water, where 96 feet will be added to the length of the vessel.

Production Division of Emergency Fleet Corporation Establishes Office in Chicago

So many contracts for material and ships' parts have been let in the Chicago district that a Divisional Office of the Production Division of the Emergency Fleet Corporation has been established in Chicago. The office, in charge of E. O. Sessions, is in the Edison Building and occupies half of the ninth floor.

Contracts for materials and parts amounting to many millions of dollars will soon be let in the Chicago district, according to Chairman Hurley. About half of the boilers needed for the new emergency fleet are being built in the Chicago district. One reason why Mr. Hurley is anxious to have more work done in this district is that he has found from experience that he can ship a carload of steel from Gary, Ind., to Seattle in less time than it can be shipped from Pittsburgh to Philadelphia.

Labor Conditions

On account of the stopping of building construction there are many idle workmen in Chicago in the building trades. Union leaders place the number at 20,000 to 50,000. These men belong to twenty-eight trades and include iron workers and carpenters.

Efforts are being made to have these men go into the shipyards, but as they prefer for the most part to remain in Chicago it was hoped that a large amount of concrete construction would be taken up here. It was evident from the interviews given by Mr. Hurley and Mr. Piez to the correspondent of Marine Engineering that this will not be done.

Large Contracts Placed by Hog Island Plant Throughout Middle West

In addition to the purchasing that is handled through the new Divisional Office of the Production Division of the Emergency Fleet Corporation in Chicago, the American International Shipbuilding Corporation is having an enormous amount of work done throughout the Middle West. This corporation, which is operating the Hog Island shipyard, has four shops in Chicago, four in Minneapolis and St. Paul, one in Kansas City, the plant of the Belfontaine Bridge Company, the plant of the Brookville Bridge Company and that of Whitehead & Kales at Detroit. There is also a number of smaller shops that are under the company's control. These shops are all busy on hull fabrication

work and their output is being sent to Hog Island. It is expected that their shipments will soon amount to more than ten carloads a day.

The plants of the Illinois Steel and Inland Steel companies in the Calumet districts south of Chicago are turning out large quantities of steel plates and shapes for yards on the Atlantic coast.

Castings used in the engines come largely from the Middle West, although the 6,000-horsepower turbines to be installed in the larger boats and the 2,500-horsepower turbines to be installed in the smaller boats building at Hog Island are being constructed by the General Electric Company, of Schenectady, N. Y.

Strikers in Chicago Foundries Return to Work

Work in Chicago foundries was tied up recently by a strike of molders and core makers and a stoppage of work in all machine shops using grey iron castings seemed imminent. The men, however, have agreed to return to work and to submit their demands for higher pay to arbitration.

Wooden Yard to Be Converted to Steel Work

The shipyard of Rieboldt & Wolter at Sturgeon Bay, Wis., which has been purchased by the Universal Shipbuilding Company, Inc., capitalized at $1,500,000, will be converted from wood to steel work and will be expanded considerably.

A delegation representing the new company is now in Washington seeking contracts with the Government. Upon the return of this delegation definite plans for the future of the yard will be decided upon. Mr. Wolter will remain with the firm during the coming year at least.

The last act of the old firm, which had been in existence twenty-five years, was to launch the steamer *Sturgeon Bay*, which is one of the fleet which recently started for salt water.

Illinois Manufacturers Seek Government Contracts

The Illinois Manufacturers' War Industries Bureau has been formed in Chicago under the auspices of the Illinois State Council of Defense for the purpose of aiding owners of plants to obtain Government contracts. The Chicago Association of Commerce, the Illinois Manufacturers' Association and numerous other commercial organizations throughout the State are back of the move. Headquarters are at 72 Monroe street, in the office of the Illinois Manufacturers' Association.

The Bureau is making a survey of industrial plants, and so far 700 have reported that they have no war work and would like to get contracts. While other parts of the country report that workmen and houses are scarce, there are thousands of idle workers in Chicago, and real estate men claim there are 20,000 vacant flats and houses. It seems certain that there are many plants that can handle far more work than they now have. Both Mr. Hurley and Mr. Piez visited the office of the Bureau while in Chicago.

Construction of Canal Boats Begun

The Chicago Shipbuilding Company is at work on "canalers" that are 261 feet long, 43 feet 6 inches beam, and from 20 to 25 feet depth. They are equipped with triple-expansion reciprocating engines.

Lake Production for Ocean Service

It is said that of all the ships being built on the Great Lakes only one is to remain in Lake service. The thirty-four ships built during the fall and winter are all, it is believed, in salt water by this time. According to official announcement, it was planned to have them out of the Lakes by May 10, but no information has been given out regarding their movements. They total about 100,000 tons. Four of the ships sailed as soon as the Lakes and the St. Lawrence River were open to navigation. The remainder took on cargoes at Chicago, Duluth and other points.

These vessels are going immediately into transatlantic service. The official programme calls for the completion of twenty-three ships in shipyards on the Lakes during May. Of these, sixteen or more are so far advanced that they have begun to take on crews and cargoes. They total 53,000 tons and have been ordered into the New England coal-carrying trade by the Bureau of Operations of the Shipping Board.

Experimenting with Concrete Boiler

The Union Iron Works, San Francisco, Cal., is experimenting with the construction of a Scotch boiler in which the shell will be made of concrete held between thin steel plates.

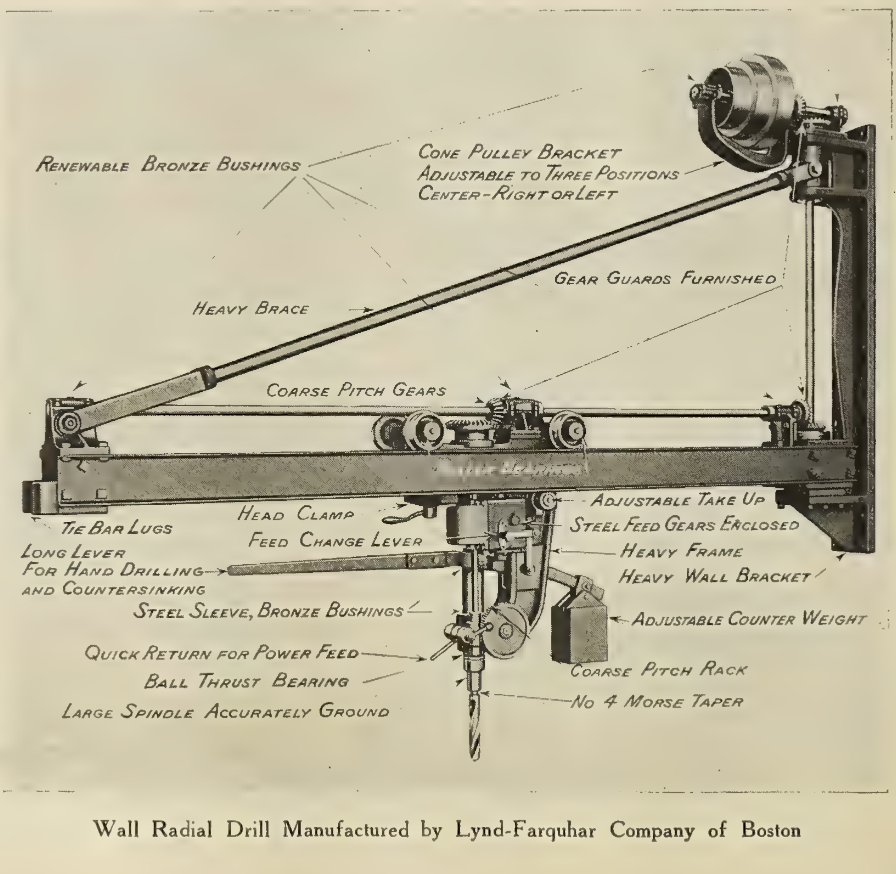
New Wall Radial Drilling Machine

The Lynd-Farquhar Company, Boston, Mass., has placed on the market a new wall radial drilling machine in which particular attention has been given to locating the entire control of the drill within easy reach of the operator. The arm on which the drill is mounted is constructed of extra heavy channels, planed on the top and bottom, with suitable supports at each end. The outer end is supported from the top of the wall bracket by heavy steel braces. The wall bracket is heavily ribbed, and where bolted to the wall is 10 inches wide and 8 feet 10½ inches high. At the top of the bracket a bevel gear housing can be located at any one of three positions for convenience in connecting the belt drive from a countershaft. In place of the bracket that carries the bevel gear housings, a 5 to 7½ horsepower variable speed motor can be mounted on suitable brackets.

The drill head is mounted on four flanged wheels fitted with roller bearings. All gears are accurately cut from the solid, the feed gears being of steel. The bearings are bronze bushed and renewable.

There is a hand lever feed nicely counterbalanced by an adjustable weight for light drilling and countersinking. The gear power feed has two changes, .015 to .025 per revolution of the spindle. The feed can be changed while the drill is in operation and provides a good range of feed for drills up to 2½ inches diameter. Automatic release of power feed is provided at the extreme traverse of the spindle to prevent damage to the feed gears.

The spindle is of high carbon steel 2½ inches diameter in the bearings and runs in long bronze bushings within a steel sleeve. The spindle has a 7-inch



Wall Radial Drill Manufactured by Lynd-Farquhar Company of Boston

Fig. 1.—General View of New South Philadelphia Works of the Westinghouse Company

traverse, a No. 4 Morse taper hole and is fitted with high-grade, heavy duty thrust bearing. The upper end of the spindle is 2⅜ inches diameter and slides through a heavy steel driving sleeve to which is keyed the main driving gear. An eccentric wheel on the underside of the arm keeps the carriage in proper adjustment along the channels.

The South Philadelphia Works of the Westinghouse Electric & Manufacturing Company

The greatly increased demand for electrical apparatus has led naturally to an increased output of steam turbine generator units and their accessories. In order to facilitate the manufacture of this line of apparatus, the Westinghouse Machine Company was a short time ago consolidated with the Westinghouse Electric & Manufacturing Company, and is now known as The Machine Works of the Electric Company.

Manufacturing facilities at East Pittsburgh, the location of both plants, have about reached their limit and further increases there were deemed inadvisable, on account of the lack of available land and the fact that there are already over 25,000 people employed in these works. It therefore became necessary to select a new site which would be capable of expansion to a size comparable with East Pittsburgh.

The site selected is at Essington, or South Philadelphia. This property, which embraces 500 acres, with a frontage of 4,500 feet along the Delaware River, lies nine miles south of Philadelphia, and can be reached by the Pennsylvania, the Philadelphia & Reading Railroads, or the Philadelphia Rapid Transit Company. The Delaware River affords a means of transportation, but as yet no docks have been built. The plant, a considerable portion of which is now in operation, is devoted entirely to the production of ship propulsion machinery for the Submarine Boat Corporation and the Merchant Ship Building Corporation, as agents for the Emergency Fleet Corporation, and also for the United States Navy.

There have been erected so far seven buildings, including the pattern storage shop, foundry, forge shop, power house, two machine shops and an erecting shop. The power and lighting systems possess a number of features of unusual interest. Desiring to make use of central station power, and at the same time secure steam for heating the buildings economically, the management has effected an arrangement with the Philadelphia Electric Company, which distributes current in this territory, that promises to work out unusually well for both companies.

Steam heat is required in the winter months, but this demand falls off, naturally, in the summer months, when no steam is required except for testing purposes. On the other hand, during the winter months, the Philadelphia Electric Company has a very heavy load, which is materially lessened during the summer months. An agreement was effected whereby the Westinghouse Company operates its own plant, non-condensing, during the winter and utilizes the exhaust steam, and when there is no need for heat, current for the operation of the works is secured from the Philadelphia Electric Company.

All of the buildings, with the exception of the pattern storage shop, are of heavy steel construction, the walls are of tile, the sash of steel, the roofs of saw-tooth type, consisting of concrete slabs covered with asphalt asbestos waterproofing material. The pattern storage shop, which at the present time houses the offices, is of reinforced concrete, of a construction known as flat slab mushroom type; the intermediate panels between the concrete posts are of tile.

The buildings are all well lighted and equipped with the most modern tools and facilities for the comfort and convenience of the workmen. Transportation between the buildings and the yards is effected by storage batery trucks, some of which are equipped with Edison batteries and some with lead batteries. Every machine in the shops is electric motor driven, and all are equipped with the latest and most approved safety devices.

Mr. H. T. Herr, vice-president, was entrusted with the seclection of the site and general direction of the construction and operation of the plant. Mr. R. B. Mildon, assistant to the vice-president, has been in direct charge of the construction work.

All business relations with Westinghouse, Church, Kerr & Company, the builders, have been handled by Calvert Townley, assistant to President E. M. Herr, who has had final approval of all arrangements.

Copy of February, 1917, Issue of Marine Engineering Wanted

A. L. Haas, a frequent contributor to Marine Engineering, will be specially grateful to any reader of this magazine who can spare a copy of the February,

Fig. 2.—Interior of Machine Shop at New Westinghouse Plant

1917, issue. This may be sent to the Editor for forwarding or sent direct to 146 Crowborough Road, Tooting, London, S. W., England.

The Tower Whirler—A New Development for Speeding Up Shipbuilding

One of the most necessary appliances about the shipbuilding plant is apparatus which will raise, move and place materials. The ideal machine of this kind is one that will lift any load within its rated capacity from any point within the reach of its boom and deposit it safely and expeditiously at any other desired point; one that will move quickly from end to end of the ways with its load or rotate quickly from material yard to shipways. It must be placed close alongside the ship being built, yet must not interfere with the operation of freight cars.

Such a machine, called a "tower whirler," is supplied by the Dravo-Doyle Company, Pittsburg, Pa. It consists of a whirler mounted on a tower from 30 to 55 feet high, running on a track having a gage of 16 to 20 feet. The whirler has a boom 75 feet, or longer, and can easily lift a 10-ton load from any point within ten feet of its center pin. It can carry the load quickly to any point along the length of its trackage, and thus, on account of the great capacity and long reach, can serve a large territory.

Several advantages are gained by mounting the whirler on a high movable tower, it is claimed. In the first place the machine is carried above any material or supplies piled on the ground, so that the long boom is permitted free use at extreme range in any part of the yard. The operator is enabled to watch his load closely every moment without the need of relying on a signalman. This often saves the cost of employing an additional man. The clearance under the tower is high enough so that an ordinary box car can pass under. Thus the whirler can unload directly from the cars and place the material either in the storage yard or in position on the ways.

In nearly all cases timber is used for the construction of the tower. Timber has several advantages not possessed by steel for this purpose. It is easy to assemble, low in first cost, easy for the ordinary workman to repair, it has great flexibility, is easy to ship, and, most important, *can be obtained*. Whirlers are operated either by steam or electricity. The ideal motive power is, of course, electricity.

Tower Whirler in Operation at Shipway

Having a track of 16- to 20-foot gage makes a very large, firm wheelbase and enables the full load to be lifted at the end of the long boom without the necessity of large counterweights. The wide gage allows for the placing of an ordinary gage track between the rails and the running of locomotives and cars under the tower. Rotation of the whirler is accomplished by means of a vertical shaft driven by a motor or an engine and bevel gears. The vertical shaft has a pinion meshing with a large gear on the truck.

Whirlers can be obtained from stock, or in sixty days at the latest. The average cost of a whirler varies from $15,000 to $25,000, and one can be shipped, complete, in an ordinary flat car. On an order of six whirlers, one could be shipped every ten days to complete the order in sixty days. For a shipyard of three ways, four whirlers would serve every lifting and placing purpose.

The whirlers at the extreme ends of the yard cover a space of 73 feet from the centerline of the whirler track, while those between the ways allow operation on either of two hulls or two whirlers on one hull.

As the great requirement now is for speed, it is pleasing to note that whirlers can operate very quickly. In the case of a 10-ton whirler, the full load can be lifted at 73 feet from the centerline on a two-part line at the rate of 75 feet per minute (or five tons on a one-part line at 150 feet per minute). The boom can be raised through an angle of 57 degrees in 25 seconds, and the whirler will make a complete 360 degrees in 30 seconds. The entire tower will move along the track with full load at the rate of 250 to 300 feet per minute.

New York State Barge Canal Opened for Navigation

The New York State Barge Canal, completed at a cost of $150,000,000, was opened to through traffic between the Hudson River and the Great Lakes on May 15. Formal observance of the opening will be held at a later date.

The main line of the Barge Canal is 352 miles long and the total length of the New York system of navigable inland waterways 532 miles.

Wainwright Turbine Bearing Oil Coolers

The use of steam turbines for ship propulsion has increased greatly the use of turbine bearing oil coolers as an auxiliary apparatus in marine work. In such installations requiring forced feed lubrication of bearings, better results are obtained at high oil velocities, as it is of advantage to circulate a large quantity of oil through a small range of temperature, thereby keeping the oil moderately near the bearing temperature, for the reason that warm oil absorbs heat more readily than cold oil.

With the exception of the tubes, Wainwright oil coolers are made of cast iron throughout, thereby eliminating the possibility of corrosion from sea water in marine work and assuring durability and long service. By the use of the Wainwright corrugated copper tube, a considerably higher rate of heat transmission is obtained in the cooler, as the tube corrugations cause a turbulent action and force all particles of the oil against the wall of the tube.

Wainwright Oil Cooler

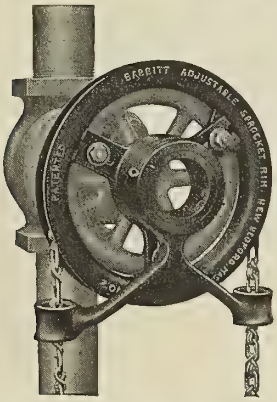
Wainwright coolers are designed on the counter-current principle with horizontal baffles cast into the shell, the warm oil entering the cooler near the point of discharge of the warm water and the cool oil being delivered from the cooler at a point where the coldest water enters. This assures a uniform rate of heat transmission through all parts of the cooling surface. The tubes are expanded rigidly into both tube sheets, the small amount of expansion being taken up by the corrugations themselves. All flanges are fitted with special oil-proof gaskets. The tubes used are straight, easily cleaned or replaced, and oil connections are located in separate channels with covers on the ends, making it possible to open the entire outfit for inspection or repair without breaking any pipe connections. The tube heads are cast separately and bolted to the shell, eliminating any chance of breakage due to shrinkage strains of the castings.

The manufacturer of the Wainwright oil coolers, the Alberger Pump & Condenser Company, 140 Cedar street, New York City, states that the construction offers compactness and maximum heat transmission with minimum requirements of cooling water and friction losses.

Chain-Operated Wheel for Valves

Up to the present time sprocket rims for the operation of inaccessible valves have been limited almost entirely to land installations, but the recent invention of a marine rim by the Babbitt Steam Specialty Company, of New Bedford, Mass., has made it possible to use such a device on board ship.

This device, called the Babbitt adjustable sprocket rim, can be attached to any valve in a few minutes by means of hook bolts. The special chain guard prevents the chain from jumping off the wheel, and also makes it possible to use the device where the valve stem is not horizontal.



Valve Wheel Fitted with Marine Rim

As opposed to other devices usually used on board ship, the Babbitt rim is very much cheaper, much more quickly installed and takes less room. There are no handles or rods occupying valuable space. When not in use the chain is hung on a special hook or is tied around a pipe. This keeps it out of the way and prevents it from rattling.

165-Foot Fir Spar Hauled from Coast to Coast

To ship a 165-foot spar weighing 12 tons from the Pacific to the Atlantic coast, four flat cars, each 45 feet long, were required, and special underpinning and swiveling arrangements were made necessary in order to allow the great spar to take the curves.

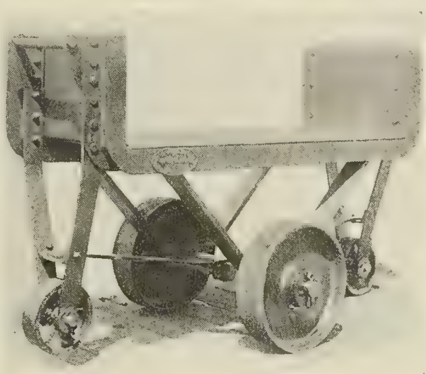
This huge spar was ordered from the Pacific Mutual Timber Company, of Tacoma, Wash., and was shipped from Onalaska, Wash., to Paul A. Lagno, a spar maker of Brooklyn, N. Y. In addition to the big stick, the shipment also contained forty-one other spars, ranging from 70 feet to 90 feet in length and from 14 inches to 22 inches in diameter at the butt.

A Modified Welding Process for Repairing or Joining Broken Aluminum Parts

The Alumunite Manufacturing Company, Inc., Corona, N. Y., has placed on the market a new alloy under the name of "alumunite," which is said to possess unusual qualities in the repairing of aluminum. This alloy has been perfected as the result of years of patient, scientific investigation and experiment. By its use it is claimed that aluminum parts can be repaired at a low cost and with none of the dangers due to high temperature welding. Alumunite flows rapidly at a temperature of 350 degrees F. as against 900 to 1,200 degrees F. required by other welding processes. Alumunite shows a tensile strength on lap and butt joints of 8,500 to 12,000 pounds per square inch.

"High Level" Truck Increases Machine Operators' Efficiency

Much time is lost and the efficiency of the machine operator is considerably reduced when he finds it necessary to stoop or bend in transferring the material from truck to machine and vice versa.


"High Level" Truck

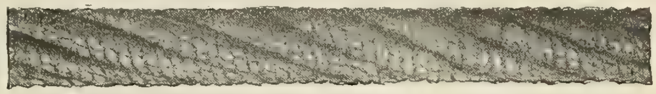
It was to eliminate this source of loss that the new "High Level" truck shown in the accompanying illustration was designed.

It is so constructed that the whole load is balanced on the center axle, which is provided with large diameter, wide tire roller bearing wheels, and, although of very heavy design, the rated capacity being two-third ton, it can be moved about fully loaded with the greatest ease.

The truck was designed and built by the Orenstein-Arthur Koppel Company, of Koppel, Pa., and is now in use in many of the large manufacturing plants throughout the country.

New Type of Wire Rope

A type of wire rope in which the steel wire strands have been specially covered with tarred hemp marline is now being marketed by the Geo. C. Moon Company, of Garwood, N. J.


Steel Wire Rope with Covered Strands

The marline covering prevents friction between the strands when the rope is in use, affords protection against moisture, keeps abrasive dust away from the wire and affords protection to the workmen's hands.

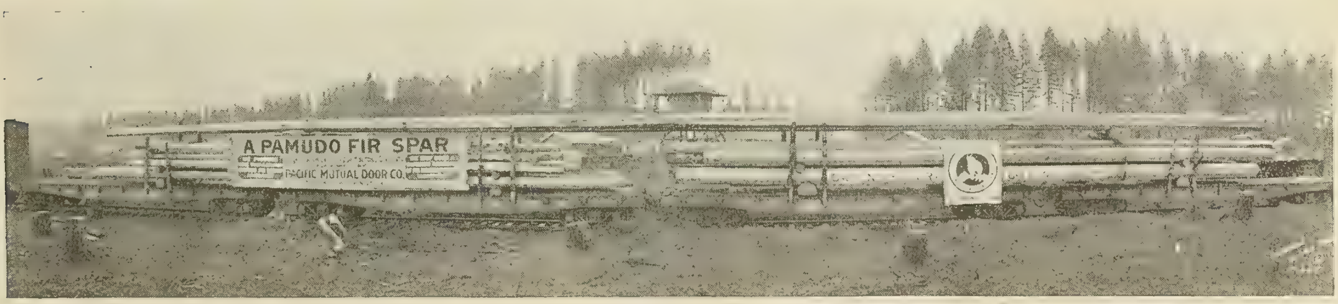
This "Crescent Hemp-Clad" wire rope, as it is called, has excellent advantages in marine service. It is flexible and can be coiled and handled as easily as manila rope, it is claimed; has from three to five times the strength for equal size, depending upon the grade of wire used, will not rust, does not swell when wet, is not affected by ice in winter and can be fastened around cleats or bits with the ease of manila rope.

For equal strength, Crescent Hemp-Clad weighs only half as much as manila rope, and, as it is only one-third of the diameter, it may be used on smaller blocks.

Record Set in Wooden Ship Launching

Portland smashed another world's record when the Grant Smith-Porter Shipbuilding Company launched the new Government steamer *Caponka* in 50 working days from the date of laying her keel. The best previous record also is held by the same company through its construction of the hull of the steamer *Wakan* in 52 working days. She was launched April 20. No other company in the United States building wooden vessels has managed so far to approach a duplication of either of these performances. Had certain material been available, the *Caponka* would have been launched in 48 days from the time the laying of her keel started. Delay was experienced in waiting for a shaft.

Helen Scott Cantine, 14-year-old daughter of E. L. Cantine, inspector at



How a Spar 165 Feet Long, 28 Inches Diameter at the Butt, Weighing 12 Tons, Was Shipped Across the Continent on Four Flat Cars

the plant for the Emergency Fleet Corporation, had the honor of christening the *Caponka*.

The eight ways of the yard are divided into two sections, one being designated as the south ways and the other as the north ways. The south ways, on which the *Caponka* was built, are in charge of C. W. Goodman, general foreman, and Ben Cassady, general fastener foreman, while the north ways are looked after by Bert Pettitt and Allan Yonker in the respective positions.

Lloyd J. Wentworth, district officer of wooden ship construction in the Portland and Columbia river district, forwarded a message of the record launching to Washington, D. C., immediately following the event.

Perhaps You Can Render Valuable Service to Your Country

Important chemical and other technical engineering work necessary for the prosecution of this war is being carried on by the Bureau of Mines Experiment Station at Washington, D. C. The services of trained men of the following classifications are urgently needed:

Bacteriologists, biologists; chemists, inorganic; chemists, organic; chemists, physical; chemists, electro-, chemical engineers, draftsmen, electrical engineers, instrument makers, laboratory assistants, laborers, machinists, physiologists, plumbers, steamfitters, stenographers, skilled labor of various kinds.

If your training fits you for any of these occupations, send to the

Bureau of Mines,
American University Experiment Station, Washington, D. C.,

for blank forms. When properly executed and returned by you, these forms will be placed on file, and when a vacancy occurs you will be considered for it and will be notified if your services are desired.

If you are a registrant in the draft and have not yet been ordered to camp, it may be possible to have you immediately inducted into the service for work here.

If you are *not* in the draft, but feel that you wish to serve your country in the present crisis, you can enlist or serve as a civilian.

Serve your country where you can serve it best.

Navy Steam Engineering School

The United States Navy Department has perfected plans for the enrollment and training of considerable numbers of engineering officers. A school for this training known as the United States Navy Steam Engineering School has been established at the Stevens Institute of Technology, Hoboken, N. J., under the guidance of Dean F. L. Pryor as Civilian Director.

The course consists of five-months' training, divided as follows: One month of military training at the Naval Training Camp, Pelham Bay Park, New York; one month at the United States Navy Steam Engineering School; two months' practical training on board ships and in repair shops in the vicinity of New York; one month finishing course at the United States Navy Steam Engineering School.

The school is open to men between 21 and 30 who are physically qualified, of thorough ability and officer-like character, and who have completed the engineering course at any recognized technical school.

This school presents particularly desirable opportunities to the young technical man, both in affording him a proper outlet for his trained facilities during the war and in rounding out his college work with a practical course and school experience which will be of value to any engineer.

The service that a graduate from the school will perform will be that of an engineer-officer in the auxiliary service of the navy. A graduate of the school will be commissioned an ensign in the Naval Reserve Force.

Information has been sent to all registered technical schools and should be on file at the President's office. For any additional details application can be made to the Civilian Director, United States Engineering School, Stevens Institute, Hoboken, N. J.

Free School of Marine Engineering

Exceptional opportunities for those desiring to qualify as engineers in the new merchant marine of the United States are offered by the Seamen's Church Institute, of 25 South street, New York City. In connection with the reorganization of the instruction in its School of Navigation and Marine Engineering, the Institute, by arrangement with the United States Shipping Board, will give free tuition to men of the requisite experience who wish to fit themselves to obtain licenses as engineers in the great transport fleet which is to convey men and munitions across the seas.

Day and Night Classes

Day and night classes are provided, so that pupils may be able to support themselves during their preparation. All applicants must be native or naturalized Americans more than nineteen years of age. Those eligible for the service must be able to meet the following requirements:

Two years' experience as marine oiler or water tender; or graduate from the engineering class of a nautical schoolship; or graduate in mechanical engineering from a school of technology; or a stationary engineer for one year; or a locomotive engineer's license for one year; or a journeyman machinist on marine, locomotive or stationary engines for one year; or an apprentice machinist of six months' experience on marine engines; or an engineer of lake, bay, sound or river steamers; or have had three years' experience as fireman on an ocean-going vessel.

Tuition Courses

In addition to the free courses provided in co-operation with the Shipping Board, the School offers courses at nominal rates for all who desire to qualify themselves for masters or mates and for all phases of sea duty. The course in marine engineering is constantly supplemented by practical work on board a modern steamship in New York Harbor.

NEW SHIPYARDS AND EXTENSIONS

Additions and Improvements

The Standard Shipbuilding Corporation, 44 Whitehall street, New York, J. Messel, purchasing agent, has leased the shipbuilding works of the Birch Point shipyard, Wiscasset, Me., and will build six vessels there.

The Pacific Construction Company, Coquitlam, B. C., is planning to build four additional ways. The company is reported to have received an order to build fifteen ships.

The Bangor - Brewer Shipbuilding Company has been organized in Bangor, Me. Charles D. Stanford is president and George H. Hamlin, treasurer.

The Svendsen Shipbuilding Company has been organized by A. A. Roman and P. Svendsen, 351 Sixty-fourth street, Brooklyn, N. Y.

The Coastwise Ship Engineering Corporation has been organized in Boston. James L. MacEachern is president and William W. Rich, 85 Devonshire street, treasurer.

It is reported that the Virginia Shipbuilding Corporation, Alexandria, Va., has awarded contracts to the Raymond Concrete Pile Company, 90 West street, New York, and to Frederick T. Ley Company, 19 West Forty-fourth street, New York, for the construction of a shipbuilding plant on the Potomac River, to cost about $5,000,000.

Cristoffer Hannevig, 139 Broadway, New York, the head of Hannevig & Company, of Norway, has acquired a tract of land in New Jersey, where, according to report, there is to be built one of the largest shipyards in the world, to construct vessels for Norwegian owners.

The Todd Shipyards Corporation, 15 Whitehall street, New York, has given a contract to B. S. Cronin & Company, 573 Clinton street, Brooklyn, for a $100,000 addition to its shipyard.

The Wilmington Wood Ship Construction Company has been organized at Wilmington, N. C., to succeed Cushman & McKown, builders of wooden vessels.

The Adamant Brick Company, Pinellas Park, Fla., is planning to build several concrete ships.

The Athens Shipbuilding Corporation has been organized by H. R. Avery, Athens, N. Y., and E. S. Anthony, Coxsackie, N. Y.

The Federal Shipbuilding Company, 71 Broadway, New York, has bought twenty-one acres of land on the west bank of the Hackensack River, where it is proposed to build an enlargement to its plant.

The Strachan Shipbuilding Company, of Brunswick, Ga., according to report, is planning to build a steel shipyard on a site to be decided later.

The Ferguson Steel & Iron Company, Buffalo, N. Y., has begun work on a shipyard on the Buffalo River. Captain James E. Ferguson is president. The yard will build vessels for the United States Navy, but later on it is planned to equip it for building all types of steel vessels.

It is reported that the Foundation Company, 233 Broadway, New York, purchasing agent E. E. Jenkins, will build a $1,250,000 plant at New Orleans,

where steel ships of a new unsinkable type will be built.

The Norway Pacific Dry Dock & Construction Company, Everett, Wash., is planning to build a shipyard.

The Fairhaven Shipbuilding Company has been organized at Fairhaven, Mass. C. G. Whiton, New Bedford, is president.

It is reported that the Gildersleeve Ship Construction Company, purchasing agent Alfred Gildersleeve, Gildersleeve, Conn., is about to erect a shipyard at Portland, Conn., where the company will build ten 114-foot lighters.

The Narranganset Shipbuilding Company has been organized at Fall River, Mass. Herder C. Wood, Fall River, is president, and Albert B. Murdough, Watertown, Mass., is treasurer.

The Foundation Company, 233 Broadway, New York, Franklin Remington, president, has formed several subsidiary companies. One has been formed for the purpose of taking over the shipbuilding plant of the Reid Wrecking Company, Port Huron, Mich. Another has taken over the Carpenter-Watkins Company, Savannah, Ga., where it will build two hundred 110-foot wooden barges for the United States Shipping Board.

The Foundation Company has also made an offer to take over the M. A. Sweeney Shipyard & Foundry Company, the Howard Shipyard & Dry Dock Company, and the B. S. Barmore Shipyard, Jeffersonville, Ind., where it plans to establish a plant for manufacturing ship parts, river boats, barges, etc.

It is reported that a new corporation will establish a shipyard at Milwaukee, Wis., for the construction of both steel and reinforced concrete ships. The corporation is being organized by members of the Society of Iron & Steel Fabricators and the Concrete Builders' Association of Milwaukee.

The Marine Department of the Houston Bank & Trust Company, Houston, Tex., is building concrete ships. E. V. Heidenrich, of the Heidenrich Engineering Company, Kansas City, Mo., is consulting engineer.

The Cleveland Builders Supply Company, Cleveland, Ohio, will build a plant for the construction of concrete ships of Welland Canal size.

The Dauntless Shipbuilding Company, Essex, Conn., S. S. Bowles, general manager, is planning improvements to cost about $100,000.

The Bangor Shipbuilding Corporation has been organized in Bangor, Me., to build wooden schooners. Chas. Murray is president, and Roscoe H. Wing, general manager.

Capt. O. A. Gilbert, of the Boston Ship Transport Company, Boston, Mass., has purchased the Story & Wardwells shipyard, East Boston.

The Johnston Shipbuilding, Repair & Dry Dock Company has been organized in Brooklyn, N. Y., by G. Johnston.

The Norfolk Concrete Boat Company, McKevitt Building, Norfolk, Va., is planning a shipyard for the construction of concrete-steel vessels. Fred B. Doty is president.

Philip Morrison, of the Seaborn Shipbuilding Company, Tacoma, Wash., according to report, will erect a ship equipment plant.

The Concrete Shipbuilding Company, Savannah, Ga., has been organized by Ivar Widing, Savannah, and others.

C. L. Bergendahl is planning to erect a steel shipyard at Wilmington, N. C.

The Jacksonville Ship Outfitting Yard of the California Brick Company will establish a plant at Jacksonville, Fla., for the mechanical equipment of ships. It is stated that the company has already received a contract to complete more than twenty wooden hulls for the United States Shipping Board. The president is W. S. Dickie, Kansas City, Mo.; vice-president, R. C. Penfield, Chicago, Ill.; general manager, John C. Temple, Jacksonville.

The Alabama Dry Dock & Shipbuilding Company, Mobile, Ala., will enlarge its plant.

Ira S. Bushey & Son, 764 Court street, Brooklyn, N. Y., have acquired a frontage of 500 feet on the Gowanus Canal as a site for a new plant.

The Galveston Dry Dock & Construction Company, Galveston, Tex., has awarded a contract to the Missouri Valley Bridge & Iron Company, Leavenworth, Kan., to construct its 10,000-ton floating dry dock on Pelican Island; the estimated cost is $850,000. The plans and specifications are by William T. Donnelly, 17 Battery Place, New York.

The Newport Shipbuilding Corporation, Los Angeles, Cal., has just been incorporated for the purpose of building steel-concrete vessels. Lloyd R. Coffman, W. R. Jamison and others of Los Angeles are the incorporators.

The Cast Steel Ship Company has been incorporated by J. H. Mottola, H. H. Hoffnagle and L. F. Sniffin, 49 Wall street, New York.

The International Sales Corporation, Munsey Building, Washington, D. C., is an organization seeking to personally represent in that city the larger industrial concerns who have or may have business with the numerous Government boards. It is manufacturing, under contract with the Shipping Board, several iron products and is prepared to take over the entire outfitting of wooden ships.

PERSONAL

HOWARD COONLEY, president of the Walworth Manufacturing Company, of Boston, has been appointed vice-president of the Emergency Fleet Corporation in charge of the legal, financial, auditing, contract, statistical and executive and administrative divisions.

J. L. ACKERSON, naval constructor, U. S. N., has been appointed assistant to the Director-General of the Emergency Fleet Corporation. He was formerly assistant to Vice-President Piez.

WILLIAM G. COXE, formerly president of the Harlan & Hollingsworth Corporation, Wilmington, Del., has been appointed Director of Ship Construction in the private yards along the Delaware River for the Emergency Fleet Corporation.

H. C. SADLER, professor of naval architecture and marine engineering of the University of Michigan, Ann Arbor, Mich., has been appointed assistant manager of steel ship construction of the Emergency Fleet Corporation.

A. MERRITT TAYLOR, former Director of Transit of Philadelphia, has been appointed director of the new division of passenger transportation and housing of the Emergency Fleet Corporation.

J. WILLISON SMITH, vice-president of the Land Title & Trust Company, Philadelphia, has been appointed assistant director of housing for the Emergency Fleet Corporation.

FREDERICK D. HERBERT, New York manager of the Terry Steam Turbine Company, has been elected president and general manager of the Kearfott Engineering Company, Inc., New York. For a number of years Mr. Herbert was editor of MARINE ENGINEERING, and for the last ten years has had charge of the New York offices of the Terry Steam Turbine Company, Hartford, Conn. Mr. Herbert will continue to handle the marine account of the Terry Steam Turbine Company, with offices at 95 Liberty street.

H. E. SQUIRE, assistant engineer California State Board of Harbor Commissioners, has been called to Washington to assist R. J. Wig, of the United States Shipping Board, who is giving special attention to the concrete division.

WILLIAM NEWMAN, naval architect, has resigned as works manager of the Polsen Iron Works & Steel Shipbuilding Company, Toronto, Ontario, Canada.

J. J. EASON has been appointed works manager with the United States & Cuban Allied Works Engineering Corporation, operating the Havana Iron Works and the Havana Dry Dock Company in Cuba. His address is Havana Iron Works, Cuba No. 51, Havana, Cuba.

E. E. MAHER has been appointed by the Terry Steam Turbine Company, Hartford, Conn., as manager for the Chicago district, with offices at 1328-29 McCormick Building, 322 South Michigan avenue. John T. Stout has been appointed manager of the New York office of the Terry Steam Turbine Company.

D. C. NEWMAN COLLINS, architect and engineer, announces change of address to 14 John street, New York City.

GEORGE Q. PALMER has been elected chairman of the Board of Directors of the Alberger Pump & Condenser Company, New York. The other officers are William S. Doran, president; William R. Wilson, vice-president; Richard C. Williams, secretary, and Frederick A. Brockmeier, treasurer.

V. F. SIGNORELLI, formerly secretary and assistant treasurer of the Southwark Foundry & Machine Company, Philadelphia, Pa., is now office manager and auditor of the Foundation Company-Carpenter-Watkins, Inc., Brunswick, Ga.

OBITUARY

FREDERICK REMSEN HUTTON, honorary secretary of the United Engineering Society and for twenty-five years secretary of the American Society of Mechanical Engineers, died on May 14 in New York, aged 65. From 1877 to 1907 Professor Hutton held the chair of mechanical engineering at Columbia and for six years was Dean of the Faculty of Applied Science.

EDWARD C. MEIER, president of the Heine Safety Boiler Company, Phoenixville, Pa., died suddenly in Philadelphia on May 7 while attending a meeting of the District Production Division of the Emergency Fleet Corporation. Mr. Meier was 48 years old and was the son of the late Col. E. D. Meier, founder of the Heine Safety Boiler Company and former president of the American Society of Mechanical Engineers.

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

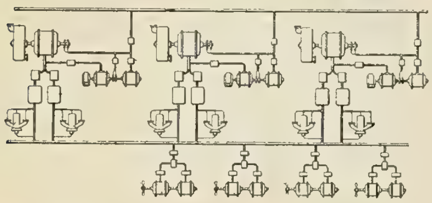
American patents, compiled by George A. Hutchinson, Esq., registered patent attorney, Washington Loan and Trust Building, Washington, D. C.

1,244,762. METHOD OF CONSTRUCTING THE HULLS OF SHIPS. PHER H. NELSON, OF DULUTH, MINN.

Claim 1.—A ship hull comprising a plurality of ribs, planking supported therefrom and a filling of cement between said ribs, some of which cement extends into spaces betwen the planks of the planking and against which the planking presses when said planking swells under the action of water. Five claims.

1,262,497. ELECTRICAL SYSTEM OF SHIP PROPULSION. HENRY M. HOBART OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY.

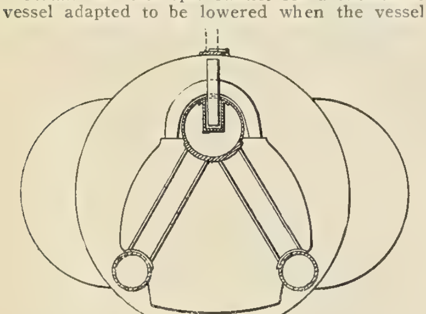
Claim 1.—An electrical system of ship propulsion comprising in combination an elastic fluid turbine, a polyphase alternator coupled to said turbine, electric current rectifying means electrically connected to said alternator



and adapted to convert the alternating current energy generated by said alternator to high potential direct current energy, a plurality of propellers, a direct current electric motor directly coupled to each of said propellers and supplied with said high potential direct current energy, and means for varying the speed of the ship by varying the field strengths of said motors. Four claims.

1,260,848. FUNNEL OF SUBMARINE VESSELS. HAROLD E. YARROW, OF GLASGOW, SCOTLAND.

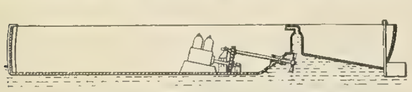
Claim.—A telescopic funnel for a submarine vessel adapted to be lowered when the vessel



is submerged into a housing provided in the steam drum.

1,263,052. TUNNEL-BOAT. CARL H. FOWLER, OF NEW YORK, N. Y.

Claim 1.—A boat having a series of tunnel chambers open at the bottom and longitudinally arranged, shafts extending into said chambers



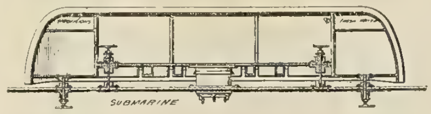
from the interior of the boat, propellers thereon within said chambers, power-generating means, and connections between the same and said propeller shafts. Five claims.

1,239,978. APPARATUS FOR INDICATING THE SPEED OF SHIPS. RICHARD STAR, OF NEWPORT, R. I.

Claim 1.—In an apparatus the combination with an indicator, of means for controlling the same comprising an actuator composed of three superposed expansible chambers, that is a pressure chamber, a suction chamber, and an intermediate chamber charged with liquid and provided with a movable head, an inlet pipe opening into said pressure chamber and communicating with the water of flotation, a suction pipe opening into said suction chamber and also communicating with the water of flotation, and a stand pipe adapted to contain a column of liquid connected to said liquid chamber, for balancing the pressure on said movable head. Seventeen claims.

1,259,534. SUBMARINE LIFE-BOAT. ST. CLAIR LEWARK, OF MAMIE, NORTH CAROLINA.

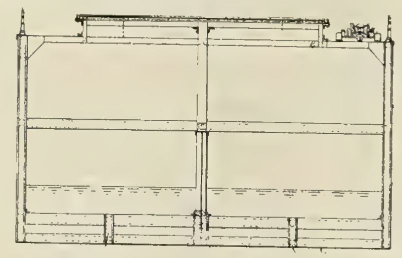
Claim 1.—The combination with a submarine, of a lifeboat inverted and detachable means secured thereon, said lifeboat and submarine having telescoping tubular extensions projecting therefrom and providing for communication therebetween, each of said tubular extensions



being provided with a packing ring at its inner end to receive the outer end of the opposite extension, and each being provided with an inwardly projecting flange having an annular rib around its inner edge, a hatch or cover for each of the extensions provided with a packing ring to receive the rib of its respective flange, and securing means at the inner and outer sides of each of said flanges for engagement with the hatches or covers at the inner and outer sides of the latter. Nine claims.

1,259,540. SHIP CONSTRUCTION. ALEXANDER McDOUGALL, OF DULUTH, MINNESOTA.

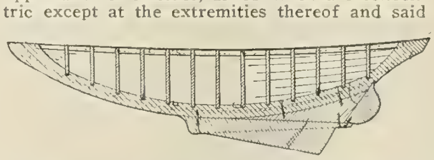
Claim 1.—The combination with a ship's hull substantially rectangular in cross section, having an inner bottom or tank top therein and thwartship beams intermediate the tank top and the uppermost deck beams, of a fore and



aft bulkhead extending from the tank top to the underside of the thwartship beams, stanchions intermediate the thwartship beams, resting upon the bulkhead and extending upwardly above the uppermost deck beams, and a continuous elevated hatch trunk extending the full length of the cargo hold of the ship supported at its sides upon the uppermost deck beams and at its center upon the stanchions. Ten claims.

1,259,572. BOAT-HULL. URQUHART WILCOX, OF BUFFALO, NEW YORK.

Claim 3.—A boat hull comprising a backbone having a keel, a stem post at the front end of the keel, said keel having curved rabbets on its laterally opposite sides and curved upper and lower sides, all of which are concentric except at the extremities thereof and said



stern and stem posts having their upper and lower sides diverging outwardly and provided on laterally opposite sides with rabbets which are curved on a shorter radius than the upper and lower sides and rabbets of the keel ribs mounted on said keel, and a skin applied to said backbone and ribs and fitted in said rabbets. Ten claims.

1,259,627. SUBMARINE LIFE BOAT. ERNEST P. HOWE, OF CLINTON, MASSACHUSETTS.

Claim 1.—The combination with a submarine and a lifeboat therefor, of means to detachably secure said boats together, said means comprising a plurality of pins mounted in said lifeboat and adapted to enter corresponding pockets in said submarine, racks connected to said pins, pinions engaging said racks to move said pins axially, arms connected to said pinions, links connected to said arms and means to move said links simultaneously to withdraw said pins. Six claims.

1,246,771. STEAM-CONDENSING PLANT. DONALD BARNES MORISON, OF HARTLEPOOL, ENGLAND.

Claim 1.—Apparatus comprising a number of steam operated ejectors (exceeding two) arranged in series for withdrawing from a low pressure and discharging to a higher pressure, said ejectors being so constructed that the degree of compression in each successive stage of compression, from the lower to the higher pressure, is greater than in the preceding stage. Sixteen claims.

1,246,968. DETACHABLE MEANS FOR LIFEBOATS. JOHN ALEXANDER McNABB, OF COLLINGWOOD, ONTARIO, CANADA, ASSIGNOR OF ONE-THIRD TO GEORGE TINEGATE.

Claim 1.—The combination with a boat; standards supported one at each end thereof; a coupling hook pivoted to each of the said standards, and having its free end projecting thereabove; and means whereby said coupling hooks may, under suitable conditions, be moved to uncouple the boat from the coupling members supported by the davits; of a keeper pivoted to each of said standards; and means whereby said keepers are locked to maintain them normally in the path of releasing movement of said coupling members. Two claims.

1,250,235. SEPARABLE-TORPEDO CONSTRUCTION. HAROLD W. SHONNARD, OF UPPER MONTCLAIR, N. J., ASSIGNOR TO CRUCIBLE STEEL COMPANY OF AMERICA.

Claim 1.—In an automobile torpedo, the combination of adjoining separable fore and aft shell sections, a separable fluid conduit leading from the one to the other of said sections, one conduit part being secured to each shell section, a conduit-coupling head attached to each conduit part, and a rotatable connecting member engaging said heads, one of said shell sections being provided with an opening adjacent to said member, and said member being provided with a head engagable for continuous rotation by a tool inserted through said shell opening. Three claims.

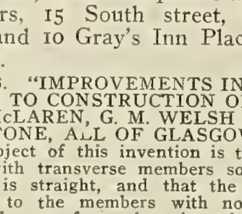
1,260,978. DEVICE FOR CLOSING OPENINGS IN THE HULLS OF VESSELS BELOW THE WATER-LINE. CONRAD STEWART HENSLEE, OF NORTH CHATTANOOGA, TENNESSEE.

Claim 1.—In a device for closing openings below the water line in the hull of a vessel, a closure member adapted to be firmly held pressed by water pressure against the hull of a vessel to close an opening therein a plurality of cups connected with the closure member operable under the influence of water passing through said opening to guide the closure member into position to close the opening, and a flexible reinforced plate to underlie said closure member and opening engageable with the vessel. Six claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

110,516. "IMPROVEMENTS IN AND RELATING TO CONSTRUCTION OF SHIPS." W. D. McLAREN, G. M. WELSH AND J. G. JOHNSTONE, ALL OF GLASGOW.

The object of this invention is to construct a ship with transverse members so that each member is straight, and that the plates are attached to the members with no distortion from a plane surface other than that involved in slight twisting and bending of the plates between the members. A shell plate may be readily given this slight deformation when cold, and consequently the work of framing and plating the ship is of a simpler nature than that required for ships of ordinary shape. One manner in which the invention may be carried out is shown in the drawing. It will be observed that the half section of the ship at any station is represented by two straight lines.



One line is a section through the bottom of the vessel, and the other a section through the side. These two lines are shown intersecting at a point which lies on a knuckle extending throughout the length of the ship. The construction in way of the knuckle may be made of an angle bar having the side plating riveted to one flange and the bottom plating to the other. The knuckle may, however, be made in any other manner, such as by flanging the side plate to the bottom plate, or *vice versa*, or by introducing a curved plate of small width instead of the above-mentioned angle bar. It will be observed that there is only a single knuckle on each side of the ship, and that straight floors are laid transversely from knuckle to knuckle.

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Prompt Delivery of Ship Machinery Imperative

WITH the rapidly increasing rate of production in the shipyards all doubt as to the ability of the shipbuilding industry to supply ships' hulls as fast as they are needed has been dispelled. But without the prompt delivery of machinery and equipment for the vessels the shipping programme may still fall short of its requirements. According to statements recently made by Director General Schwab before the American Boiler Manufacturers' Association, some eighty or ninety hulls are in the water waiting for various items of machinery and equipment. Failure in this regard, especially in the early months of the shipbuilding programme, would seem less excusable than delays in hull work, for at the outset there were available in the country ample facilities capable of being adapted to the building of engines, boilers and other marine machinery, whereas it was necessary to provide a large part of the shipbuilding facilities before the hull work could be begun. Every effort, of course, is now being directed by the government officials to this phase of the situation, and the encouraging announcement has been made that hereafter troop ships and freighters building for the Emergency Fleet Corporation are to have precedence in the supply of turbines over naval vessels. But until the marine engineering facilities of the country catch up with our enormously increased shipbuilding facilities the obligation will rest on all contractors and manufacturers engaged in this phase of the work to concentrate every available resource upon speeding up production.

May Shipbuilding Records

MAY ship deliveries in the United States totaled 44 vessels of 263,571 deadweight tons, while the May launchings included vessels of 344,450 deadweight tons, establishing records never before equaled in the history of American shipbuilding. The output in the United Kingdom in May amounted to 197,274 gross tons, and for the twelve months ending May 31, 1,406,838 gross tons. Against these production figures the total allied and neutral shipping sunk by German U-boats in May, according to Navy Department estimates, amounted to less than 260,000 gross tons.

The figures for this year's shipbuilding (in deadweight tons), as published by the Shipping Board for the United States and the United Kingdom are as follows:

	United States	United Kingdom
January	88,507	87,852
February	123,625	150,057
March	172,611	252,511
April	160,286	169,000
May	263,571	......

The greatest year in the history of shipbuilding in the United Kingdom was 1913, when the output was 2,898,229 deadweight tons, or a monthly average of 241,519 tons. Last year, the United Kingdom produced 1,741,500 deadweight tons, or a monthly average of 145,125 tons. The best month was March, with 238,239 deadweight tons.

The output of May in the United States was three times that of January of the present year and brings the total deliveries since September, 1917, up to 170 vessels, aggregating 1,112,897 tons. The record pre-war year in American shipbuilding was 1901, when the output (exclusive of the Great Lakes) was 402,136 tons, or a monthly average of 33,511 tons.

That the record May output will soon be exceeded is indicated by the fact that no less than 89 vessels aggregating 439,886 deadweight tons are scheduled for launching on July 4. No effort will be spared to bring the monthly output up to half a million tons and when that goal is reached the expectations of the Shipping Board, as outlined by Chairman Hurley elsewhere in this issue, will have ample promise of fulfillment.

Effect of the German U-Boat Raid

IF the German submarine raid begun off the Atlantic coast on May 25 was designed to intimidate American shipping it failed signally of its purpose. During the interval while the raiders were destroying ten American vessels, totaling 26,000 tons, American shipbuilders were turning out 21 new vessels, totaling 130,642 deadweight tons, or over 100,000 tons more than the total losses. Further than this, the spirit of determination aroused in the shipbuilding and shipping industries will continue to react against the enemy until final victory is won.

Employment Men Wanted by the Shipping Board

THE Industrial Service Section of the United States Shipping Board Emergency Fleet Corporation is in need of men qualified to serve as employment managers, assistant employment managers and interviewers for shipyard employment work. Men of industrial experience closely allied to shipyard work are desired, who, after a six weeks' course in the fundamentals of employment management, will be in a position to render valuable service in shipyard work in the capacity of employment managers or assistant employment managers. For this work, men of good appearance and address will be required, possessing general intelligence, tact and other general qualifications which, combined with their industrial experience and training in employment work, will make them of immediate value as employment men. The second class of men required should also have industrial

experience closely allied to the shipbuilding trades, so that they can enter the employment departments of the shipyards as interviewers for selecting skilled shipyard help. Recruits for this work should communicate at once with C. W. Doten, acting head, Industrial Service Section, Emergency Fleet Corporation, Philadelphia, Pa.

Proper Designation for Pipe

REFERENCES to pipe in technical articles, specifications and elsewhere are too frequently inaccurate and misleading. There are three proper designations for pipe: wrought pipe, wrought iron pipe and steel pipe. Wrought pipe is the generic term for steel or iron pipe and is a proper designation for either. Wrought iron pipe means just what it says and refers to the product of a pudding furnace. Steel pipe also means exactly what it says but represents about 90 percent of the present output of wrought pipe in the United States. By reason of the fact that wrought iron pipe was the original pipe manufactured, the term is still erroneously used and the chances are ten to one that the product referred to by this term is in reality steel pipe, which, in the absence of definite information, should be termed "wrought pipe" and not "wrought iron pipe."

England's Merchant Marine Founded on Coal Trade

THE United Kingdom produced in 1913 only 22 percent of the coal production of the world but exported nearly 50 percent of the world's exports of coal, while the United States produced nearly 40 percent of the world's production and approximately only 12 percent of the world's exports.

If, however, only the sea-borne foreign coal trade be considered, the British over-seas trade in coal in 1913 was more than twice that of the whole world put together, or approximately 71 percent of the world's trade. All of the foreign coal trade of Britain is sea-borne, while the greater portion of the coal exported from the United States is shipped by rail into Canada, so that the share of the United States in the world's sea-borne foreign coal trade was in 1913 approximately only 4 percent. The significance of this situation is shown by the following extract from *Commerce Reports*.

The immense foreign coal trade of the United Kingdom, which reached a total of nearly 100,000,000 tons in 1913, is the foundation upon which has been built the entire foreign commerce of the country as well as the expansion of the mercantile marine. For the transportation of this coal, the building of an immense fleet of steamers was necessary. Without the coal trade, Britain would not have by far the largest mercantile marine in the world. According to Lloyd's Register for 1915-16, the merchant shipping of the world amounted to 49,261,769 gross tons, of which 19,541,368 tons were owned in the United Kingdom, the United States being next with only 5,892,639 tons, and Germany with 4,706,027 tons. The United Kingdom has been able to send its coal to all parts of the world at a cheap freight rate for the reason that the ships were always able to obtain return cargoes of raw materials needed for the manufacturing industries at home, such as wool, cotton, ores, and timber. In this way the outward freight on coal and the homeward freights on raw materials were low, thus making it difficult for countries like the United States to compete. The United States, not being a large importer of food or other heavy commodities suitable for return cargoes on coal exporting vessels, in exporting coal to foreign countries frequently was unable to obtain return cargoes and consequently the coal exporters had to bear the cost of the round trip.

Coal is thus the basis of Britain's mercantile shipping and manufacturing industry. Coal enabled British shipowners to obtain outward freights on vessels proceeding to foreign ports for needed raw materials; coal enabled British manufacturers to obtain low freight rates on imported raw materials, thus making it possible to manufacture at a cost so low that these manufactured goods could be exported. Without a great export trade in coal, Great Britain could not have become the greatest shipping country in the world and one of the greatest exporters of manufactured goods.

Since the outbreak of war Britain's exports of coal have so declined to South America that a largely increased market has been found for coal from the United States. Whether at the end of the war the South American market can be retained by United States exporters of coal will depend largely on the freight rates. If American ships taking coal to South America have to return in ballast, it will probably be impossible to compete with British rates. Every inducement, therefore, seems needed to increase the imports into the United States from South America. The establishment in the United States of free ports would assist greatly, as then South American products could be imported as return cargoes on coal-exporting vessels for storage free of duty in the free ports for re-exportation to Europe and other countries.

The United States is by far the greatest coal-producing country in the world. It is of vital necessity that large foreign markets be found for American coal. As has been shown above, coal is the basis of a great foreign trade. But a large export trade cannot be obtained unless there is also a great import trade; for otherwise shipping would have to bear the cost of steamers returning empty.

Stopping the Engines on Torpedoed Ships

CASES have occurred when vessels have been torpedoed and in immediate danger of sinking where it has been impossible to stop the engines due either to an escape of steam in the engine and boiler rooms or to the flooding of the engine room. The result has been that owing to the speed at which the vessel was moving through the water the ship's boats could not be launched or, if launched, were capsized on reaching the water and lives have been lost. It is, therefore, important that means be provided in all steamships for stopping the engines from the deck or the engine room skylight hatchway. The marine department of the Board of Trade points out this necessity and suggests three ways in which this can readily be done.

The first method is to connect a wire rope to the throttle valve lever (or the lever on the governor spindle in some cases), lead it to a point in or near the engine room skylight hatchway whence the lever can be operated and the throttle valve shut. Normally the rope is allowed sufficient slack to admit of the free movement of the lever in maneuvering the engines. A second method is by a simple arrangement of rods and wheel connected to the stop valve of each main engine for shutting the valve from the position indicated in the first method. Where there are few boilers a third method is suggested, consisting of fitting rods from the boiler stop valve to the top of the boiler casing, with suitable hand wheels for closing the valves from that position.

American Merchant Marine Will Total 25,000,000 Tons in 1920*

7,000,000 Tons of Shipping Now Under Control of Shipping Board—Present Programme Calls for 14,715,000 Tons Additional—819 Shipways in the United States

BY EDWARD N. HURLEY†

BEFORE the formation of the present Shipping Board Secretary McAdoo of the Treasury insisted that our pioneering upon the seas must in the future be done by an interest having boundless resources; an interest that is not compelled to concern itself with dividends to its stockholders, or returns to its bondholders; an interest that can afford to suffer losses and sustain them for an indefinite period; an interest that has a single purpose—the general welfare of the United States as a whole. Obviously, there is but one such interest, and that is the Government of the United States.

Before the war ocean commerce traveled in bottoms owned and operated by private capital. Now this gigantic merchant fleet which we are turning out is to be controlled by one central body by the greatest corporation in the Western World—the United States of America.

On July 1, 1916, we had no merchant marine worthy of the name engaged in overseas trade. It is true that we had under the American flag a total deadweight tonnage on that date of 2,412,381 tons, but approximately eighty percent of this tonnage was engaged in coastwise and Great Lakes trade. Therefore the vast supplies which we were sending abroad were shipped under terms and conditions laid down by other nations, because the great bulk of our exports was carried in ships flying foreign flags.

4,500,000 Tons of Shipping Added to American Merchant Marine

Now we are beginning to fulfill our destiny. On June 1, 1918, we had increased the American-built tonnage to over 3,500,000 deadweight tons of shipping. In the eleven months from July 1, 1917, to June 1, 1918, we constructed in American shipyards a tonnage equal to the total output of American yards during the entire previous four years. In short, the Shipping Board has added approximately 1,000,000 tons of new construction to American Shipping in the last ten months, for it was not until August 3d of last year that our commandeering order went into effect. We have also added 118 German and Austrian vessels, with a total deadweight tonnage of 730,-176. We have requisitioned from the Dutch under the order of the President, 86 vessels with a total deadweight tonnage of 526,532. In addition we have chartered from neutral countries 215 vessels with an aggregate deadweight tonnage of 953,661. This tonnage, together with the vessels which we have been obliged to leave in the coastwise and Great Lakes trade, gives us a total of more than 1,400 ships with an approximate total deadweight tonnage of 7,000,000 tons now under the control of the United States Shipping Board.

In round numbers, and from all sources, we have added to the American flag since our war against Germany began, nearly 4,500,000 tons of shipping. We are adding to this tonnage rapidly and will continue to do so. It has taken us some time to apply to the shipbuilding industry of this country the principles of organization and progressive manufacturing which have made our other big institutions the marvel of the world.

Record May Production

Since January of the present year, when our new quantity production of ships may well be said to have just begun, we have steadily risen in our monthly output until in the month of May we turned out a total of 260,000 tons for that one month alone, making a total for the first five months of this year of 118 steel ships, aggregating 805,000 deadweight tons. Now, in the year ending July 1, 1915, the shipyards in this country built 186,700 deadweight tons of steel vessels of over 1,500 deadweight tons. Thus, in the month of May we produced 53,000 tons more than were produced in the entire year 1915. During the year ending July 1, 1916, 281,400 deadweight tons of steel vessels were delivered. Adding the 1915 tonnage with the 1916 tonnage gives a total of 468,100 tons. With a tonnage for the first five months of this year of 805,000 tons, we delivered in five months 336,900 tons of shipping more than was built in American shipyards in the years 1915 and 1916. I do not believe I am over optimistic in saying that our tonnage output will continue to increase until before this year closes we will be turning out a half million tons each month.

We have established a shipbuilding industry that will make us a great maritime nation. We have to-day under contract and construction 819 shipbuilding ways, including wood, steel and concrete, which is twice as many shipbuilding ways as there are in all the rest of the shipyards of the world combined. Our programme for the future should appeal to the pride of all loyal and patriotic Americans. In the early part of May the members of the Shipping Board appeared before the Appropriation Committee of Congress with a request for additional funds for our extended programme.

Present Programme Calls for 14,715,000 Tons

Our programme calls for the building of 1,856 passenger, cargo, refrigerator ships and tankers, ranging from 5,000 to 12,000 tons each with an aggregate deadweight tonnage of 13,000,000. We are also contracting for 200 wooden barges, 50 concrete barges, 100 concrete oil carrying barges, and 150 steel, wood and concrete tugs of 1,000 horsepower for ocean and harbor service, which aggregate a total deadweight tonnage of 850,000.

Exclusive of the above, we have 245 commandeered vessels, taken over from foreign and domestic owners, which are being completed by the Emergency Fleet Corporation. These will average 7,000 tons each and aggregate a total deadweight tonnage of 1,715,000.

This makes a total of 2,101 vessels exclusive of tugs and barges which are being built and will be put on the seas by the Emergency Fleet Corporation in the course of carrying out the present programme, with an aggregate deadweight tonnage of 14,715,000.

Five billion dollars (£1,025,000,000) will be required to finish our programme for 1918, 1919 and 1920 but the ex-

* From an address delivered at commencement exercises at University of Notre Dame, South Bend, Ind., on June 10.

† Chairman of the United States Shipping Board.

penditure of this enormous sum will give to the American people the greatest merchant fleet ever assembled in the history of the world—a fleet which I predict will serve all humanity loyally and unselfishly upon the same principles of liberty and justice which brought about the establishment of this free republic. The expenditure of the enormous sum will give America a merchant fleet aggregating 25,000,000 tons of shipping.

American workmen have made the expansion of recent months possible and they will make possible the successful conclusion of the whole programme. On July 1, 1917, there were in the United States not quite 45,000 men engaged in the shipbuilding yards. To-day we have a force of 300,000 men in the yards, and 250,000 men engaged in allied trades. This force will be continuously increased. From all present expectations it is likely that by 1920 we shall have close to a million men working on American merchant ships and their equipment.

The Year's Output

The most liberal estimate of this year's output of shipping from all countries, except America, does not exceed 4,000,000 tons. One of the ablest shipbuilders in the United States, Mr. Homer Ferguson, of Newport News, predicted before the Senate Committee in January that out tonnage for this year would be 3,000,000 tons in the United States alone. Mr. Powell, vice-president of the Bethlehem Steel Shipbuilding Company, agreed with Mr. Ferguson. Mr. Schwab, the Director-General of the Emergency Fleet Corporation, has told me that he is going to prove that both of these good friends of his are somewhat conservative. He believes that the expert prediction of 3,000,000 tons can be exceeded, and I agree with him.

We have gradually reached the point where we have the facilities for constantly increasing our output.

As I have said, we have a total of 819 shipways in the United States. Of these 819, a total of 751, all of which except 90 are completed, are being utilized by the Emergency Fleet Corporation for the building of American merchant ships.

751 Building Ways for Cargo Ships

In 1919 the average tonnage of steel, wood and concrete ships continuously building on each way should be about 6,000 tons. If we are using 751 ways on cargo ships, and can average three ships a year per way we should turn out in one year 13,518,000 tons, which is more than has been turned out by Great Britain in any five years of her history.

When all our wood, steel and concrete shipyards are thoroughly organized, with a keel laid on each of the 819 ways, our fabricating plants driving ahead at full speed, and employees more thoroughly trained in the art of ship construction, it is estimated that we can turn out from each way more than three ships a year.

The United States Shipping Board is not only the greatest shipbuilder in the world but is the greatest ship operator. In perfecting our organization we not only perfected that part of it which is building the ships but we have also another part which operates the ships. The operating side is called the "Division of Operations;" under the management of Edward F. Carry, Director of Operations; its function is to see that all the ships in the service are well managed and that rates are properly adjusted. The great shortage in the world's tonnage and other courses brought about extremely high ocean rates. These high ocean rates have been felt in the rising prices of all seaborne commodities. One of the most important phases of the work of the Division of Operation has been to lower ocean rates as much as has been possible. One result of this reduction has been to make it possible for our Allies to receive their necessary munitions and supplies at much less cost.

The total gross revenue of our fleet is very impressive. From the ships under the control of the Shipping Board a total gross revenue is derived of about $360,000,000 (£74,000,000), an amount more than the gross revenue of the New York Central Railroad and almost equal to that of the Atchison, Topeka & Santa Fe Railroad, and the New York Central Railroad combined.

Shipping Control Committee

The Shipping Control Committee, composed of Mr. P. A. S. Franklin, chairman, Mr. H. H. Raymond, and Sir Connop Guthrie, K. B. E., was appointed in the early part of February, 1918, jointly by the Secretary of War and the United States Shipping Board. The appointment was the outgrowth of several months' experiment, and which had clearly demonstrated the necessity of having the entire merchant fleet operated under a single head with the one object of winning the war. Since its appointment the committee has directed the movement of all supplies destined for the troops overseas, which, considering the vastly increased army now in France, is a very great accomplishment. The committee has also operated vessels under requisition of the Board and has chartered neutral shipping to carry essential raw materials to manufacturers in the United States and the various commodities needed here and abroad. Nitrates have been brought from Chile, manganese from Brazil, chrome from New Caledonia, hides and wool from the Argentine, sugar from the West Indies and Porto Rico, and various other essentials from all parts of the world. The committee has also supplied vessels to take care of the desperate food situation in Belgium.

If in 1919-'20 we have the passenger and cargo tonnage we have planned, we will be in a position to establish a weekly passenger service between New York and Rio de Janeiro, Montevideo, Buenos Aires and Caracas on the east coast, and weekly service between Colombia, Ecuador, Peru and Valparaiso, Chile, on the western coast. On the west coast we now have two fast passenger steamers plying between New York and Valparaiso. These are the first to carry the American flag on that route. They have cut the time between these two important cities from 27 to 18 days—a saving of 9 days.

New Steamship Service

Our Central American neighbors, Mexico, Guatemala, Nicaragua, Honduras and Costa Rica must all have the very best passenger and cargo service, as must all of our South American neighbors. We have planned the class of steamers required for this service. The type will serve our Latin American friends in a manner that they have never been served before, but which they are entitled to. With the wonderful resources which these countries have, their products should be distributed in the world's markets and they should have sufficient ships at their disposition and at such rates that will enable them when it is necessary, to sell their products in competition with other nations. This will give them an opportunity to receive their share of profits which will permit them to further develop their countries.

On the Pacific we must provide sufficient tonnage to meet Russia's requirements. That country has many products which we need. These articles can be moved in

bottoms controlled by us at fair freight rates and this will be most helpful to the expansion of Russia's trade.

China also has many commodities which we require, and should receive the transportation necessary to move them, not only to our country, but to other countries that she may desire to sell to.

What better use can we make of our merchant marine than to assure to these countries the best possible regular steamship service?

That progressive nation, Japan, is rapidly upbuilding her own merchant marine, but the demand for tonnage will be so great on the Pacific that Russia, China, Australia, and other foreign possessions will receive service which they have never been able to receive before.

Terminal Facilities

The building and operating of vast fleets for the United States is not the only work the Shipping Board is doing to create and develop a great merchant marine. Linked to this work is the work done by the Board in helping to develop our harbor and port terminal facilities. A Port and Harbor Commission has been appointed with Mr. Edward F. Carry as chairman, and in co-operation with the Army, Navy, Railroad Administration and Shipping interests we expect to develop and organize our harbors so that the great merchant marine we are creating will have full facilities for speedy loading and unloading, and for the dispatching of cargoes into the interior and the receiving of cargoes from the interior. With that development of drydocks and bunkering and repair facilities, we shall have the most modern improvements, which will enable us, in co-operation with the railroads, to load and unload ships quickly, thereby saving time and preventing delays of our ships in port.

All the warring nations now recognize that the chief issue which Germany will raise when compelled to sue for peace will be the issue of raw materials. There is indisputable evidence that this is now the principal fear of the German industrial and financial leaders. No nation can participate in the commerce of the world without an adequate supply of raw materials. Manufacturing nations must have oil, cotton, copper, steel and iron, if they are to survive industrially.

A neutral diplomat who has spent some time in Berlin recently brought back to Washington a report of the physical breakdown of Mr. Albert Ballin, managing director of the Hamburg-American Line, once the shipping master of Germany. Mr. Ballin, prior to the European war, was one of those who recognized that the Prussian military leaders were set upon trying out their military organization. He had expressed the opinion that it was inconceivable that the Kaiser would agree to such a cold-blooded project, especially as Germany had such a great merchant marine and all the place in the sun that any reasonable nation could desire. Mr. Ballin did not reckon with the character of a nation which had been taught for generations that whatever it wished to do could be achieved by military power alone.

Mr. Ballin is one of the victims of the German system of militarism. The merchant marine which he built up is swept from the seas. The instruments which might have been of service to the German people, had they used their strength for peace instead of war, are now stripped from them. Mr. Ballin, I have been told, is a physical wreck. Germany herself must become a wreck, by her own acts, if the war continues. She has been forced recently to commandeer the copper from household plumbing; the doorknobs, kettles, bathroom fixtures, and even the extra suits of clothing possessed by her citizens. This is her internal struggle for raw materials. In peace, as well as war, she must have the raw materials which other nations produce, or she cannot recover industrially. In the end, raw materials will mean more to her than the military map to which Hindenburg and Ludendorf have glued their eyes.

Government Attitude on the Concrete Ship

Congress and Shipping Board Open Minded as to Concrete Ship Construction—Merits of New Type of Vessel Must Be Proved

BY WALDON FAWCETT

WHAT is the United States Governmental attitude and more especially the Congressional attitude on the concrete ship proposition? This is a question which has been asked very frequently during the past few weeks; and assuredly it is pertinent, since the extent of the concrete shipbuilding programme must, perforce, be dependent upon Congressional authorization and Congressional appropriation. It is a question which is, furthermore, entirely excusable by reason of the fact that with the single exception of aeroplane construction no wartime proposal before the national government has induced more argument at Washington than this self-same concrete ship programme. It would doubtless be unjust to say that it has been an incentive to lobbying, but it has at least been the objective in political as well as engineering maneuvers and has revealed the steel manufacturing interests arrayed against the cement interests with an eye to future business in materials.

To answer, as well as may be, the question in the preceding paragraph, it may be said that, by and large, executive authority at Washington is receptive, unconvinced, but of absolutely open mind, albeit hopeful, with respect to the concrete ship. There are, of course, enthusiasts in the United States Shipping Board Emergency Fleet Corporation who feel that the trial trips on the Pacific of the *Faith* fully vindicate the concrete ship, but the general attitude in administrative circles at the seat of government is one of waiting for more conclusive results.

Forty-two Concrete Ships Authorized

Hesitancy to commit the Government, unreservedly, to a policy of maximum production of concrete ships does not signify, however, grudging consent to a comprehensive demonstrational programme. The best evidence in refutation of that is found in the fact that the Shipping Board has authorized the construction of a total of forty-two concrete ships, of which eighteen are already under contract. Nevertheless, there has plainly been suspicion on the part of champions of the concrete ship, both in Congress and in the shipbuilding industry, that obstructionist tactics were being employed at Washington to deny full recognition to concrete construction. This was the

explanation, in part at least, of the recent move designed to secure a special Congressional appropriation of $50,000,000 (£10,250,000) for the construction of concrete ships.

When there was disclosed in the Committee on Commerce of the United States Senate a spirit of opposition to such heavy expenditure at this time for concrete ships the attitude was misunderstood by a considerable portion of the public and interpreted as expressive of prejudice against concrete ships. As a matter of fact the underlying motive was one of resentment not at the proposal for concrete ships but because of the attempt to (by reference to another Senatorial committee) take the concrete ship proposition out of the hands of the body which has up to this time handled all the legislation relative to the Governmental plan for building up the mercantile marine. In other words it was a political rather than a technical monkey wrench that had been thrown into the machinery.

Not Antagonistic to Concrete Ships

As a matter of fact the Commerce Committee has, at no stage, been antagonistic to concrete ships, and for all that the fact has never become public, this body weeks ago authorized by the Emergency Fleet Corporation to go ahead and expend any sum up to $10,000,000 (£2,050,000) for the construction and test of concrete ships. The Senatorial "board of directors" did not create a special fund for a try-out of concrete construction, but it did, in effect, advise the Governmental shipbuilding organization to go ahead and expend any sum up to $10,000,000 (£2,050,000) from the general fund at its disposal with the assurance that if, after the expenditure of the $10,000,000 (£2,050,000) it developed that the concrete ship was a disappointment there would be no question raised by the Senatorial supervisors of the shipbuilding programme regarding the wisdom or justification for the expenditure.

Regret was expressed in shipbuilding circles when premature announcement was made that all of the concrete ships to be constructed to the order of the Emergency Fleet Corporation would be tankers. The misgivings as to the narrowness of the range of demonstrational service thus afforded were, however, unjustified. To be sure, a majority of the 42 ships sanctioned by the Shipping Board will be tankers of 7,500 tons to operate at a calculated speed of 10½ knots, but a certain proportion of the vessels will be cargo ships of 3,000 to 3,500 tons. The engineering qualifications and the adaptability of the concrete construction will be even more diversely tested by supplemental programmes of construction in which other branches of the United States Government are following the lead of the Fleet Corporation.

Diversity of Types

As different as may be, for instance, from the service required of the concrete craft in the fuel oil trade will be the exactness imposed upon concrete tugs and barges in commission in deep-water harbors and upon American inland waterways. Such versatility of application is, however, in immediate prospect. At the request of the Inland Waterway Commission, the Department of Concrete Ship Construction of the Emergency Fleet Corporation has prepared plans for a 500-ton concrete tow barge and the Commission proposes to place not less than a score of towing craft of this type in commission on the Erie Canal. Meanwhile the Bureau of Construction and Repair of the Navy Department contracted for twelve concrete barges of 500 tons each, for harbor service, and the Quartermaster's Department of the War Department announced that it would accept concrete as an alternative for wood in tug construction, the initial concession in this respect on the part of the War Department being made in connection with an order for twenty-two tugs.

Cost of Construction

Students or observers within the shipbuilding industry of the progress of the idea of concrete construction will naturally watch with especial interest the effect of climatic conditions, etc., upon actual construction. The weight of this factor should be conclusively determined, it would seem, by the location of concrete shipyards at points so diverse at Wilmington, N. C.; Jacksonville, Florida; Mobile, Alabama; San Francisco, Cal.; San Diego, Cal.; New York City, and Brunswick, Georgia. Disclosure of cost figures covering building operations on a large scale will likewise be awaited with the keenest curiosity. One of the prime advantages claimed by advocates of concrete ships is the alleged economy of construction. Their contention has been that the new concrete ships could not show a cost in excess of $110 (22/18/4) per ton as compared with $165 (34/7/6) per ton ascribed to wooden construction and an estimate of $180 to $220 (37/10/0 to 45/16/8) placed upon steel ships. Set over against any advantage that the concrete ship may show in initial cost will have to be the allowance for more rapid depreciation if it should prove that, in salt water, concrete will show a more rapid rate of deterioration than wood or steel.

Books for All Men in United States' Service Are Provided by the Library War Service of the American Library Association

At the request of the War Department Commission on Training Camp Activities, the American Library Association has undertaken to supply reading matter to the men of our army and navy, wherever they may be. This service extends to 39 large camps, to small camps and stations, to vessels, hospitals, transports, and overseas. It is the aim of the service to send books to every point where U. S. soldiers, sailors, and marines are stationed.

Books and magazines of all kinds are available; good stories; technical books on military tactics, electricity, machine shop work, trench fighting, aeronautics, automobiles, gas and such subjects; poetry; biography; books about the war; in fact, all books that men like to read.

If there are no A. L. A. books in any place where men are stationed, all that is necessary to obtain them is to send the following data to the Library War Service Headquarters, Library of Congress, Washington, D. C.

Name and address of camp (or vessel).

Kind of camp (or vessel).

Approximate number of men in camp (or on board).

What agencies are supplying reading matter and to what extent.

What local library, if any, is co-operating.

How many and what kind of books are needed.

How many magazines are needed.

Where will reading matter be housed.

Who should be notified when books and magazines are shipped.

Will he arrange for the circulation of this reading matter throughout the entire camp (or vessel).

There is no red tape about getting the books; men in charge will be asked to keep simple records, instructions for which are furnished with each library.

The Big Concrete Ship Not Unreasonable

A Reply to Professor Everett's Article on "The Fallacy of Concrete Ship Construction"—Views of an Advocate of Reinforced Concrete Vessels

BY J. F. SPRINGER

IN the February issue appeared an article entitled "The Fallacy of Concrete Ships." This article comes from the pen of Professor H. A. Everett, who holds the chair of Marine Engineering in the Post Graduate Department of the United States Naval Academy. Perhaps the author's attitude is not so well expressed by the title as by the concluding words. They read:

"To sum up briefly, we are justified in expecting success for reinforced concrete construction for barges, still-water craft and perhaps small ocean-going craft of simple form, but are entirely unjustified at the present time in expecting large ocean-going craft to be successful, and should not be led astray by undue optimism."

In the same issue of MARINE ENGINEERING appeared an extended statement of the plans and specifications relating to a 5,000-ton reinforced concrete ship, which has, in the short interval, since been launched and successfully undergone harbor trials. This ship is named the *Faith*. It is far and away the biggest commitment to reinforced concrete for ship construction. Was the building of this vessel justified "at the present time"? I understand Professor Everett in effect to say No. It is possible, however, that the builders knew some facts of which, or of whose significance, the professor is still unaware. The name *Faith* suggests that they did not have full knowledge and it also suggests that they knew enough to be confident.

Basis of Confidence in Concrete Ships

It may be profitable to set forth the grounds on which our confidence may rest in respect to such ships. The present writer is not a ship designer. His point of view is that of one more or less acquainted with concrete and its characteristics. Probably, nearly everyone now considering this question which is bringing together two differeent lines of development will be handicapped by knowing something less than an adequate amount in one or the other. Professor Everett has given, presumably, a conception of the status of affairs as viewed by one who is more or less of a stranger to the history of concrete. I propose to make some contribution from the side of the new material.

Concrete is old, not to say ancient. Reinforced concrete is a new thing in the world. There may have been some sporadic cases in the somewhat distant past of iron imbedded in concrete. But reinforced concrete means more than a juxtaposition of concrete and steel in a single mass. Steel itself consists of two things, iron and carbon. And yet it is neither the one nor the other. It is much the same with reinforced concrete. It is a new material that is neither plain concrete nor steel. Plain concrete is fairly strong in compression; so much so, in fact, that it is extensively used for foundation purposes. But it is weak in tension. There are no suspension bridges of plain concrete. Reinforced concrete is the result of successful efforts to make good this deficiency in an otherwise splendid construction material. Steel has wonderful tensile strength. Furthermore, the coefficients of linear expansion of plain concrete and steel are approximately the same (being in the neighborhood of 0.0000055 and 0.0000066 per degree F., respectively). Reinforced concrete consists of the plain material in which have been imbedded comparatively small amounts of steel in locations where tension stresses are to be expected. Thus a beam which is to be loaded on top needs little or no reinforcements in the upper part but does require its presence in the lower part. The natural compressive resistance of plain concrete takes care of the purely compressive stresses in the upper part, while the steel takes the tension load in the lower part.

In a ship, the reinforcement will naturally be located where there will be tension stresses. Where compression reigns alone, reinforcement will ordinarily be unnecessary.

Reinforcement for Tension Stresses

Now a concrete ship, like many other structures, is made up of parts, some of which are perpetually or occasionally subject to tension stresses, and of other parts where they do not occur. Probably, in so complex a thing as a big ship, the designer may not everywhere be able to assign the precise maximum tension stresses that will occur and will, in consequence, be driven to the safe course of using at these points unnecessary amounts of steel. Similarly with compression stresses, it is to be expected that they will not everywhere be known with exactness and that the designer will be compelled to assign excessive cross-sections of concrete at this point and that, in order not to introduce risk. That is to say, we may expect the first big ships to be overheavy on account of the excessive amounts both of concrete and of steel. It is reasonable to regard the objections to concrete ships which are founded on the weight of the structure to become less pertinent with the growth of knowledge.

The specific gravity of concrete is around 2.25. The reinforcement will not add greatly to this. Naturally, it will vary between wide limits. For an average, I make the guess of 3 as an outside figure. With steel at 7.85, we may see at once that we may make the shell of the hull 2½ times as thick as a steel one and not increase the weight. It will be seen, then, upon consideration, that while 3 to 4½ or more inches may be required for the thickness of the concrete shell, this will not mean such an enormous addition to the weight.

Concrete Vessel Heavier than Steel

Similar remarks apply to frames and other auxiliary numbers. Doubtless, a reinforced concrete vessel of the same deadweight-carrying capacity as a steel vessel will be bigger and heavier. This is granted. But attention should be focussed upon the point that the excess displacement grows proportionately less as the carrying capacity goes up. In short, the big ocean-going stone ship exceeds the steel sister vessels to a relatively smaller extent than does the small boat. This point has been well brought out by T. J. Guerrite, in his article on Ferro-Concrete Ships, published on page 328 of the June issue. The data for the steel ships come from members of the staff of Messrs. Sir W. G. Armstrong, Whitworth & Company, Ltd., and for the concrete vessels they have been calculated by M. Guerrite in collaboration with a member of the staff of Messrs. Vickers, Ltd. For steel and concrete ships of 1,000 tons deadweight carrying capacity, the stone ship

exceeded in displacement by 39 percent. Corresponding to 2,000 tons capacity, the excess displacement diminishes to 25.8 percent; while for 4,000 tons capacity, the excess amounts only to 16.5 percent. When we get to the big 6,000-ton ship, the reinforced concrete boat exceeds the steel vessel in displacement only 11.8 percent. In so far, then, as the weight of the ship is concerned, the acceptability of reinforced concrete is greater than the biggest vessel. There is, from the point of view of weight, apparently no point in Professor Everett's optimism in favor of the little vessel when that optimism is conjoined with pessimism for the big fellow. In fact, if the little one is all right in respect to weight, we are to expect the big one to be much more so.

The equipment that goes onto a reinforced concrete vessel is heavier than what is needed for a steel vessel of the same carrying capacity. The total weights of the finished vessels when compared make manifest a disadvantage on the side of the stone craft. But just as the relative excess weight of the naked vessel went down as the carrying capacity went up, so here. The small concrete boat equipped is twice as heavy as the steel vessel of the same carrying capacity. But this great relative excess goes down to about 40 percent when we reach the 6,000-ton vessel. So, then, even when we take equipment into account, we find that the big reinforced concrete ship is decidedly more acceptable than the small one. In view of what has now been said, it is difficult, in so far as weight is concerned, to see any reason why we may expect success with the small boats but not with the big ones. The argument is, in fact, the other way.

Factors Affecting Net Ton-Mile Costs

No one can very well claim the excess weight of a concrete ship, on the whole, an advantage. It may, however, very well have a compensation in the way of stability. Be that as it may, let us grant at once that the prospects are that the concrete ship, because of its greater weight, is going to be a slower ship than the steel vessel. Probably, ocean greyhounds will never be built of concrete. The stone boat will doubtless begin and end as a cargo carrier. The question is whether reinforced concrete promises a solution of shipping difficulties that will enable it to develop and retain for itself a special field. Probably greater weight is going to mean greater power costs per ton-mile. But the ultimate net ton-mile cost is determined only after the consideration of a good many items. Of these, power cost is but one, although an important one. Another item, which also is only one, but which is also quite important, is that which prorates the yearly charge set down to cover the depreciation of the vessel. Here is where we may expect to get a very substantial offset to the power cost. Concrete vessels may be expected to be long-lived craft. We cannot, of course, point to actual cases of big ocean-going reinforced concrete ships that have had long lives. The *Faith,* the first 5,000-ton stone ship has only just gone into service. Steel vessels were under this same handicap at a like stage of development. Still, there is a good deal of information pertinent to this question. Reinforced concrete is, admittedly, a material of indefinite life under favorable conditions. Indeed, we have a good example of this in the case of a reinforced concrete boat where the conditions have not been so very favorable. In 1849, a rowing skiff of reinforced concrete was constructed. In 1917, it was reported to be still in existence and still in its original condition. If water is going to penetrate into concrete and cause the steel to rust and consequently expand, and such expansion is going to rupture the concrete, this boat has given the water and the rust a good long time to do whatever they are going to do. Doubtless, Mons. Lambot's skiff floated only in fresh water, and has not been subjected to certain chemical activities which some seem to think sea water may be able to set in motion. However, I am not relying on this boat as affording the whole ground for expecting the *Faith,* for example, to outlive contemporary wooden and steel vessels. But the little skiff bears its quota of testimony in favor of long life.

Damage and Deterioration

There are, it would appear, two principal sources from which damage and deterioration may conceivably come. These are mechanical shocks and chemical disintegration. We have, with respect to the former, no experience with big concrete ships upon which to fall back. But there is a good deal of experience with reinforced concrete in miscellaneous structures. I call attention, first of all, to the common practice of driving reinforced concrete piles by means of the blows of a pile driver. There is more or less cushioning by means of blocks interposed between the hammer and the pile head. At the same time, the penetration of the pile is derived from the shock of the blow. This practice is nothing new nor novel. It is a very usual thing. There may be a disposition to grant that this illustration certainly favors the idea that reinforced concrete may be constructed to resist successfully tremendous blows, provided they are deadened somewhat, but that it does not show a capability of resistance to a very quick and powerful blow. Very well, let the example be restricted to deadened shocks. I am content. This isn't my last example. But let us stick, for the moment, to slow acting forces and shocks. A monolithic, reinforced concrete building was in 1909 erected on 20 piers in a region where subsidence was a contingency. Six years later, sure enough, subsidence was detected. Inspection made it clear that the building had lost contact with 12 of the piers and was then being supported by only 8 out of the original 20. This must have created tremendous overstrains through the building. The report summing up the results of an examination into affairs said: "Thorough inspection of the whole building, with special attention to main beams, secondary beams and ceilings, failed to reveal any trace of weakness or strain." It hung together, didn't it? Take a similar case, only this time with a reinforced concrete boat built by a Norwegian concrete-vessel concern. The boat was a lighter of 100 tons deadweight, which measured 64 feet between perpendiculars and weighed 58 tons. This vessel, when the deck concrete was 50 days old and that of the sides 30,* was provided with supports at the two ends, leaving an unsupported gap of 40 feet and having a load of 16 tons distributed evenly over the central part. The maximum total shear is estimated at 26½ tons at the inner edges of the supports, and the maximum bending moment at 419 foot-tons at the center of the span. At this center, a deflection of about 1/16 inch was noted. "There were no signs of surface cracking, flaws or weakness of any kind." One more slow-acting test of reinforced concrete. A large pier of this material was rammed or jammed by a big vessel of 8,000 tons. It is said that a timber pier would have given way to the point of letting the steamer through. "As it was, the only damage was the destruction of a few piles and about 20 square feet of decking."

Quick and powerful blows will, naturally, penetrate anything if there is plenty of rapidity and plenty of force.

* Some may wonder at the deck concrete being older than the concrete in the sides. This probably arose from the custom of this particular concern in pouring concrete vessels in an upsidedown position.

That is the way *steel* ships are pierced by shells. Not only the steel hull, but heavy armor as well. We can hardly hope that reinforced concrete or any other material will prove to be the "immovable object" capable of withstanding the "irresistible force." Steel and wood are not such materials, at any rate. An advantageous thing about swift forcible blows is that the region of damage is, with some materials, concentrated, and the surrounding construction left unharmed. Perhaps the steel hull of a ship belongs among these materials. Let us grant it. But so also does reinforced concrete. About a year and a half ago, a big explosion occurred at a British port, which threw up into the air a steel girder weighing nearly 1 (long) ton. This girder came down endwise on a reinforced concrete wharf. "It went through a panel of the decking, but the hole made was hardly more than 1 foot by 2 feet, the adjoining beams not suffering in the slightest; the damage was therefore insignificant and most easily repaired." Consider another case of quick, powerful action. On the western front in the region defended by the British was a reinforced-concrete water tower, 52 feet tall. It stood on the German side. When the Germans fell back in the spring of 1917, they dynamited the legs and brought the tank down. It fell, in fact, the full distance to the ground. "But according to written statements the shells which had struck the tank merely made circular holes through the sides and bottom....."

Effect of Mechanical Mishaps Localized

We are, I think, entitled to draw the conclusion from the foregoing examples of the behavior of reinforced concrete, when subjected both to sudden and to cushioned shocks, that at the most only local effects are to be expected from the great majority of the vicissitudes which happen to a ship in and out of port. I may close the discussion of mechanical mishaps by telling of the collision of two small reinforced concrete vessels in the Balboa dry dock basin. The vessels were pontoons 120 by 28 by 18 feet in size. These pontoons broke away from their moorings and came into violent collision with each other. One pontoon suffered no damage at all. The other pontoon had its fender carried away, the bolts having been pulled out.

We now come to the question of the possibility of disintegration and rupture of reinforced concrete through activities due to or set in motion by chemical action. Will salt water penetrate reinforcement? Will it bring about disintegration of the concrete through chemical reactions between its own ingredients and those of the concrete? Will the reinforcement attacked by the salt water become corroded, expand in consequence and thus disrupt adjoining concrete? These are serious questions which must, on the whole, have favorable answers, or reinforced concrete ships will be doomed to failure.

Action of Salt Water on Reinforced Concrete

Let us grant at once that probably all the bad things suggested as possible by these three questions will occur with concrete that falls distinctly short of being the best modern product. Concrete is made from three solid materials. All the ingredients are cheap, except one. It so happens that this expensive one is the only one that acts as a binder. Many contractors have undoubtedly tried to reduce the amount of Portland cement which went into the structures they were engaged upon. This was probably truer of a bigger percentage of responsible contractors some years ago than it is now. People know more about concrete to-day than they did a few years back. It is now coming to be understood, at least in effect, that unless there is sufficient cement to fill *all* the voids left between the pieces of sand and rock, then there will be produced a porous concrete. In fact, more cement than enough has to be put in to counteract the inevitable imperfections of mixing. Naturally, for the hull of a ship, the open decks, and any parts exposed to the action of sea water, we must use a highly dense concrete—one in which the porosity has been eliminated or reduced to a minimum. We cannot save on cement, but must use the amount which the best concrete practice indicates for dense concrete.

Dense Concrete Essential

Now, in general concrete practice, it is very often unnecessary to put the owner to the expense of ultra dense concrete. The interiors of heavy foundations and thick dams may not call for it. Buildings that stand for the most part in a dry atmosphere may not need to have the densest of concrete employed in their construction. It is probable, however, that, scattered over the country, is a big total of reinforced concrete construction which is not fully adapted to the service which it is called upon to perform. This is, in the case of important structures, more apt to be the case with buildings, piers, dams, wharfs, etc., constructed 10, 15, 20 years back than with structures recently built. Less was known then than now. We have in America, doubtless, allowed much construction by incompetent engineers and contractors.

Mr. H. S. Taft, in a paper on "Reinforced Concrete Docks," published in the *Transactions, American Society Civil Engineers* for 1915 (volume 78, page 1058), says: "In the United States the construction of reinforced concrete docks is in a very embryonic state, and the use of cement in structures standing in sea water, on the part of American engineers, has not always been successful. On the other hand, concrete has been used successfully for more than 50 years in Europe for structures exposed to the action of salt water, and English engineers have been building reinforced concrete docks for about 20 years."

Concrete Docks Successful

In discussing the question of concrete docks, a prominent New York engineer has stated: "Of the large number of concrete docks which have come under his observation, the majority have been a success, though here and there he reports a failure, due to poor construction and material, and not to defects in the design. It is authoritatively stated that the reinforced concrete docks at Southampton have shown no deterioration due to salt water action, except at the Southampton coal jetty. The engineers of the Liverpool Docks have been using concrete in connection with their work since 1872, apparently with great success.

It has been stated on the best authority that in England the alteration of 'dryness and wetness and fluctuations in temperature' does not appear to have affected reinforced concrete sea water structures adversely." In discussing the concrete docks of the Port Talbot Dock Company, Mr. William Cleaver has stated: "While reinforced concrete requires extreme care, both in the choice of material and in the supervision of the workmanship, the results justify the extensive adoption of the material for dock work."

Experiments by Mr. Baldwin-Wiseman in 1907, in England, on the permeability of concrete, show that, if it is well made, it is one of the most water-tight materials known, and that it rapidly becomes less and less porous when water is forced through it. Mr. V. de Blocq van Kuffeler, in summing up the experience in using concrete for salt water structures in Holland, says: "A suitable mixture, very carefully manufactured, the use of a good

brand of cement with trass,* and setting in a moist atmosphere, are the most efficient means of insuring the preservation of reinforced concrete in sea water."

In discussing the deterioration of steel in reinforced concrete by the action of sea water on ferro-concrete,† provided the latter is properly made, Mr. C. S. Meik, a prominent concrete engineer of England, says that such deterioration "is a negligible quantity." In support of this contention, he cites the experience at Southampton, stating "that the exposed steelwork on a pile end that had been in the sea for 8 years was much corroded," whereas the bars in the body of the concrete, on being cut open, were forced to be quite free from any rust and as fresh as the day they were put into the pile.

Professor Everett depends, in a large measure, upon an article by Professor H. J. M. Creighton on "The Deteriorating Action of Salt and Brine on Reinforced Concrete" which appeared in the *Journal of the Franklin Institute* for November, 1917. Professor Creighton relies upon his own investigation in large part, but depends in part upon others. Amongst these others is H. P. Brown, the author of an article in *The Electrician* (London), volume 69, page 915†† (1912), on "Electrolysis of Reinforced Concrete." Professor Everett is unfortunate both in his dependence upon Professor Creighton and upon Mr. Brown.

Professor Creighton's Investigations

Professor Creighton's investigation supplies quite a number of examples of deterioration which he himself has viewed They are sufficient to refute any claim that might be made to the effect that any and all reinforced concrete is impervious and will successfully resist the action of salt water. And that is about all of which it is a refutation. But, who claims that any and all reinforced concrete had such fine qualities? The present writer does not. Nor does he know of any responsible person acquainted with reinforced concrete who does make any such preposterous claim. Professor Creighton doesn't say, in so many words, "any and all," but he does the equivalent. He lists example after example without giving any real, substantial information either as to the quality of the materials that went into the concrete or as to the proportioning of the mixtures or as to any other steps that were taken or omitted which may have had in view the waterproofing of the material. In one single case, that of a thirty-years old concrete in a building in Kansas City, Professor Creighton tells us something of the character of the concrete. He states in effect that this concrete was made with *cinders*. This is a bad chicken to come to roost for Professor Everett. About the only reason that anyone could have had to use cinders was to *save money*. The presence of cinders in a concrete, at least at a point of time 30 years back, is about sufficient to condemn the concrete as probably of very inferior quality indeed. The remaining concretes of Professor Creighton's investigation are unknown quantities. This investigation, in its present state, is to be regarded as having no value for Professor Everett's purposes, as those who seriously advocate big concrete ships do not propose to construct them of anything but high quality material.

Mr. Brown's article, abstracted in *The Electrician*, is concerned with the effects of electric currents accidentally traveling along the reinforcement. If the mass of concrete is damp the currents will bridge the gaps from bar to bar and we get electrolytic action. Salt water would doubtless accentuate the bad effects. It is desirable, then, to waterproof the concrete, and this brings us to Mr. Brown's interest in waterproofing materials and compounds. Professor Everett in MARINE ENGINEERING, page, 62, correctly quotes Professor Creighton:

"Regarding the waterproofing of concrete, it should be pointed out that an impervious concrete is probably never obtained outside the laboratory. The average concrete is practically never waterproof. Although there are many substances on the market for rendering concrete waterproof, the majority of them are far from satisfactory. A number of such instances has been investigated by Brown (*The Electrician*, 65, 615, 1912), who points out that all waterproofing materials will sooner or later hydrolize, crack or distintegrate."

Mistaken Conclusions

The one professor correctly quotes the other (except for the "615"), but, apparently, the first never looked up Mr. Brown's article, and the second got, I think, a wrong impression. Mr. Brown does not state, either explicitly or implicitly, "that all waterproofing materials will sooner or later hydrolize, crack or disintegrate," as Professor Creighton makes him say, in effect. What Mr. Brown does say is this: "Permanent protection from electrolysis cannot be secured by painting or by coating a concrete structure with a membrane and waterproofing material. These will sooner or later hydrolize, or crack from settlement of structure, or disintegrate from action of gas liquor in the water." Some waterproofing materials are incorporated in the mass of the concrete and really form one of the ingredients of the mixture. These are known as *integral waterproofing* materials. Mr. Brown says, in this passage, nothing as to them. He speaks of "coating a concrete structure with a membrane and waterproofing materials." This is something else. Integral waterproofings are not applied as coatings. But Mr. Brown goes further than an expression of his disapproval of superficial waterproofings. He mentions in this article, which I commend to Professor Everett, that he did find a waterproofing substance whose action had been—up to the time when he wrote the article—perfect. He needed to find a material which when mixed with the concrete would prevent internal dampness to the extent of maintaining the insulation between steel reinforcing bars supplied by the imbedding concrete. He subjected a test block, made by mixing, with the water, sand and cement of a cement mortar, a small amount of the inexpensive paste which he names, to a continuous electric test. Hear what he says. He states that this "block after 30 days' hardening was put into salt water and its rods connected with the mains of a direct-current dynamo at 125 volts. Since November 8, 1911, it has been under this pressure continuously and shows no sign of current flow nor injury. Without "Starex" similar blocks rise in temperature at once and crack around the positive rod in two days."

In conclusion, we may, I think, say that the big concrete ship is a decided possibility. There is good, solid testimony to the effect that reinforced concrete may be made absolutely watertight, and by more than one method. The objections which relate to other things are of minor importance and are more or less offset by special advantages.

Recent press reports state that the *Faith* has made a successful voyage to Seattle and is now on her return trip. The same news item is mainly occupied with the notice of the Government's contracts which have just been made for 40 big reinforced concrete ships, each of 7,500 tons.

* A variety of volcanic tufa found on the banks of the lower Rhine.
† A transatlantic synonym for reinforced concrete.
†† An error was made in citing this reference in MARINE ENGINEERING, February, 1918, page 62. The page number should be 915 and not "615."

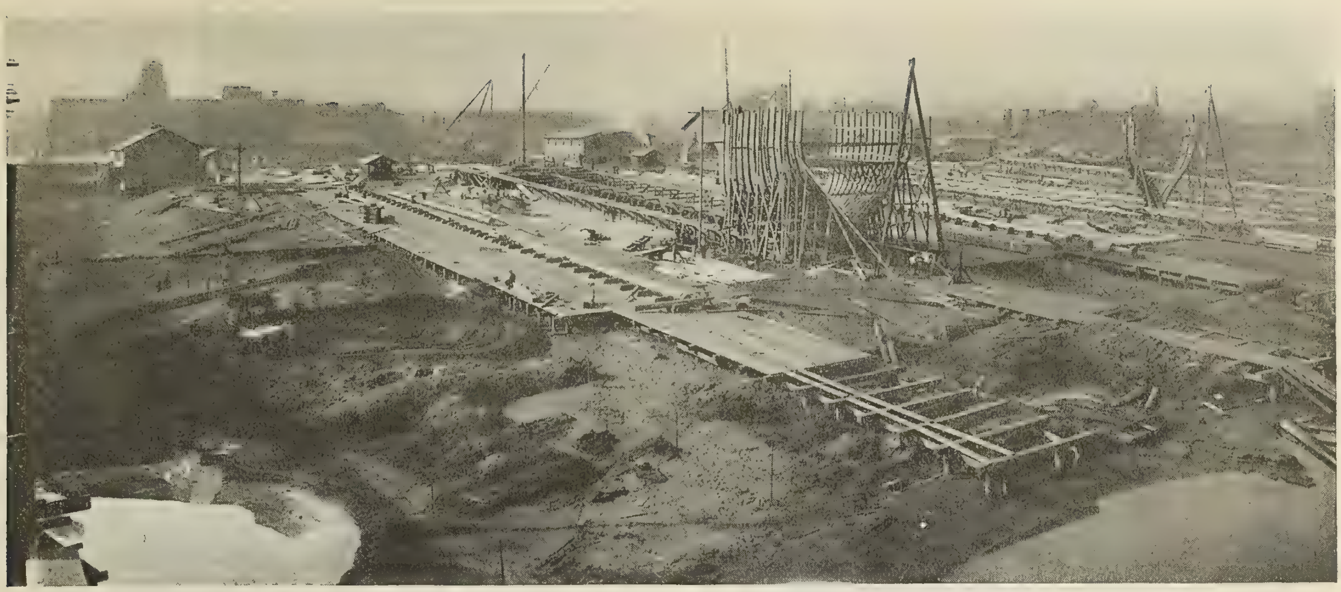


Fig. 1.—View of Foundation Yard at Portland on November 2. Construction of Vessels Begun Before Yard Was Completed

The Foundation Company–Shipbuilders

Newcomer in Shipbuilding Industry Within a Year Is Building Ninety-eight Vessels on Atlantic, Pacific and Gulf Coasts and Great Lakes

NO better example can be found of the astounding growth of the shipbuilding industry in the United States than the development of the shipbuilding facilities of The Foundation Company, of New York.

One year ago this company was equipping its first shipyard for the construction of ten wooden steamers for the United States Shipping Board. It is now operating yards on the Pacific Coast, the Atlantic Coast, the Gulf, and the Great Lakes, and has under contract a total of ninety-eight steel and wooden ships for the Governments of the United States, Great Britain and France. Nineteen of these ships have already been launched and others are following at the rate of ten a month.

Although, at first thought, there would seem to be little connection between the sinking of pneumatic caissons for deep foundations—for which the company has established a national reputation—and the building of ships, it was the organization of ship carpenters and calkers maintained for constructing wooden caissons which gave the company the nucleus of its first shipbuilding forces.

In April, 1917, Franklin Remington, president of The Foundation Company, was called to Washington to consult with the officials of the Emergency Fleet Corporation upon the possible building of wooden ships by engineering and construction companies. As a result of this meeting, The Foundation Company was authorized to equip

Fig. 2.—View of Portland Yard Two Weeks Later, Showing Vessels in Frame

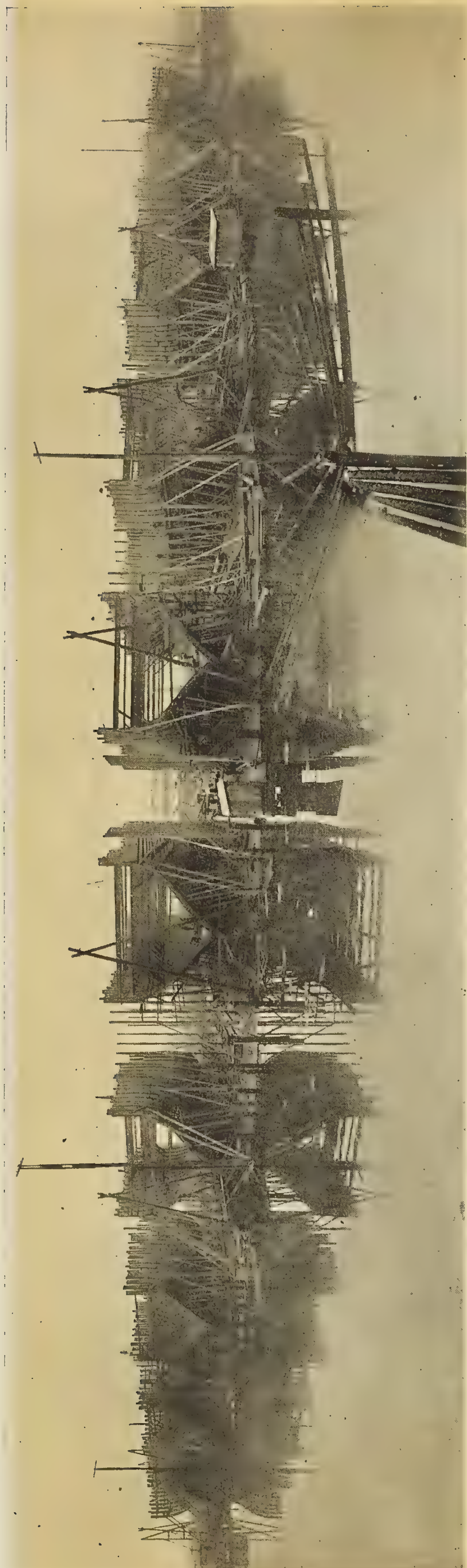


Fig. 3.—Waterfront of Portland Yard, Showing Vessels Under Construction on All Ten Ways

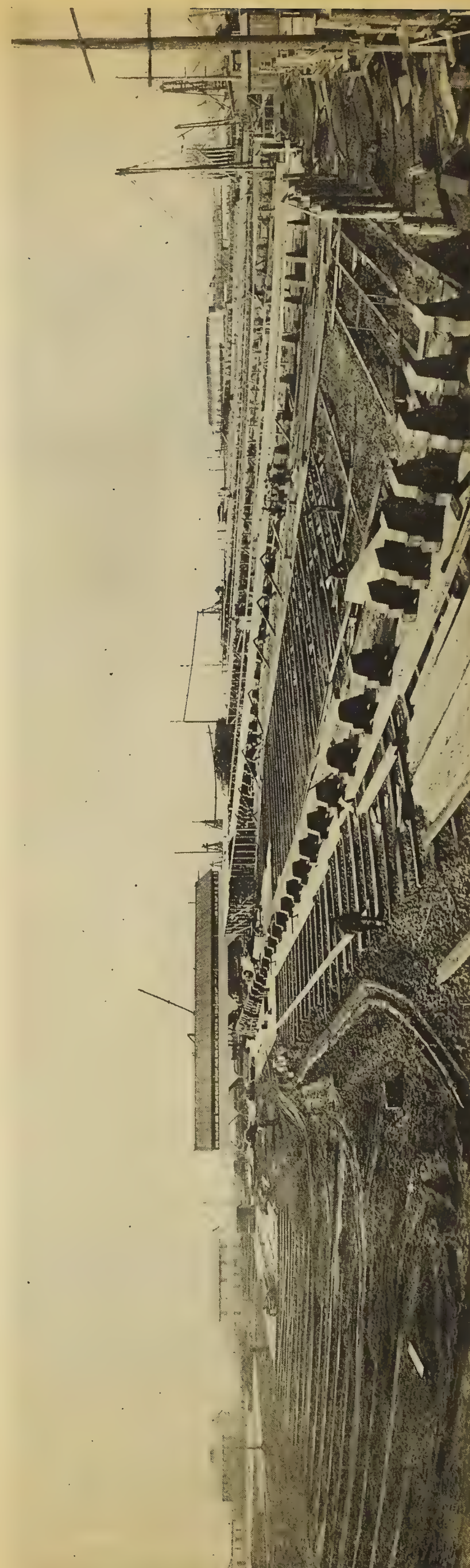


Fig. 4.—View of Tacoma Yard on November 13

THE FOUNDATION COMPANY (NEW YORK)—SHIPBUILDERS

Builders of Steel and Wooden Vessels for Great Britain, France and the United States

Fig. 5.—Fitting Out Yard at Tacoma, Wash. Wooden Auxiliary Schooners Under Construction for France

Fig. 6.—General View of Foundation Company's Yard at Portland, Ore.

a shipbuilding yard for the Government. Property on the Passaic River, near Newark, N. J., was immediately acquired and ten ways were laid down. Although the location of this yard within the metropolitan district of New York placed it at a disadvantage, because of traffic congestion, The Foundation Company was the first of twenty-three competing yards on the Atlantic and Gulf Coasts to launch a wooden ship for the Emergency Fleet Corporation.

This 3,500-ton cargo steamer, the *Coyote* (Fig. 15), has since been delivered to the Government and is being equipped with boilers and engines at the yards of the Lord Construction Company, Providence, R. I. The third and fourth ships from this yard were successfully launched on June 25.

Contract With British Imperial Munitions Board

The second contract entered into by The Foundation Company was with the British Imperial Munitions Board, for the construction of five 2,800-ton wooden cargo steamer hulls. A site for a shipyard was selected at Victoria, B. C., and four ways were laid down. Sufficient property was purchased, however, to permit of the addition of seven ways to provide for increased output. The first keel was laid on July 27, 1917, and the first hull launched on December 27.

This was the first of a fleet of 2,800-ton wooden cargo steamers contracted for by the Imperial Munitions Board with a number of shipbuilding companies on the Pacific Coast. Although The Foundation Company received its contract at the same time as the other yards, and entered the race with a handicap of several months while the Victoria site was being equipped, it launched the *War Songhee* (Fig. 7) a month ahead of its nearest competitor.

In July, 1917, The Foundation Company obtained from the French Government a contract for the construction of forty 3,000-ton wooden auxiliary schooners. It was agreed that the last of the forty vessels would be delivered in December, 1918, which called for a fast building schedule.

Vessels for French Government

The Foundation Company decided to build two additional ten-way yards for the construction of these ships, and naturally turned toward the Pacific Coast because of the abundance of heavy timber available and of favorable labor conditions. Representatives were immediately sent to Portland, Oregon, and, after making a survey of a number of possible locations, they selected a site for one of the two yards on the Willamette River, in the heart

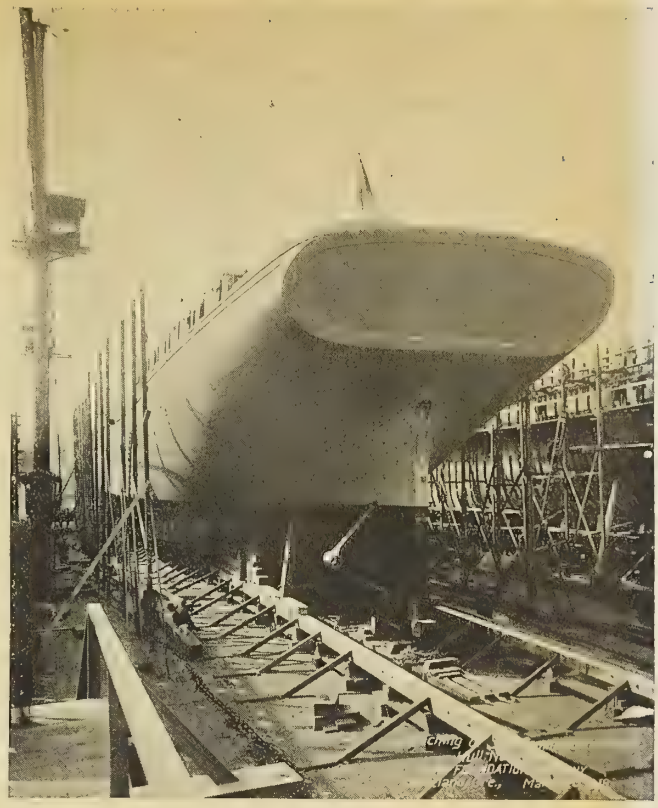


Fig. 8.—S. S. *Commandant Rosin* Ready for Launching at Portland Yard on March 20

of the city. The property has a water frontage of approximately 1,000 feet and adjoins two of the largest lumber mills in Portland. Within three days a preliminary layout had been made and progress schedule prepared. The grading of the yard required a hydraulic fill of approximately four hundred thousand cubic yards.

While this development was under way at Portland, a site for the other ten-way yard was located on the tidal flats northeast of Tacoma. Although this is within the Puget Sound territory, it is far enough away from Portland to prevent both yards from being affected by any labor troubles which might arise. The property selected had the advantage of fronting on two parallel water ways, but it required a large amount of fill, as the ground was under six feet of water at high tide.

The building ways were laid out facing east along the Hylabos waterway, with a spacing of seventy-eight feet on centers and a slope of three-quarters inch to the foot.

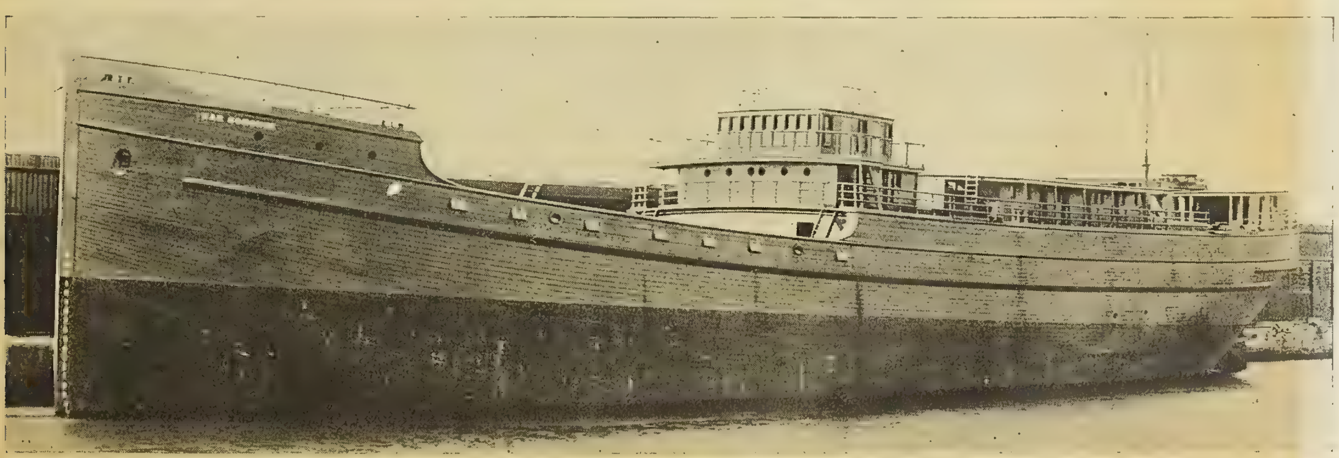


Fig. 7.—S. S. *War Songhee*, the First of a Fleet of Wooden Cargo Steamers Building by the Foundation Company for the Imperial Munitions Board

They are served by ten gantry cranes, guyed to each other and anchored to concrete deadmen.

Each mast is one hundred feet high, with a diameter of thirty-six inches at the butt and twenty-four inches at the head. It is pivoted top and bottom by means of ordinary gudgeons and carries a boom eighty feet long, at an elevation of sixty feet above the ground. At the intersection of the boom and mast, a cage is located, giving the operator a complete view of the hulls under his rig. This system was adopted only after careful consideration of the various methods of handling materials for shipbuilding. Experience has shown that the rigs are adequate for the work and are thoroughly satisfactory in their operation.

Deliveries of rough lumber are made to the Tacoma yard by both rail and water. Water deliveries are handled by stiff leg derricks from the scows to a power feed roll way leading to two Stetson-Ross timber sizers, which handle all planing for the yard. From the sizers the timber is transferred by distributing rolls to an aerial tramway serving a storage yard 60 feet by 800 feet, with a capacity of ten million feet B. M.

At Portland the lumber mills furnish ship timber already planed, so that deliveries are made to the yard by motor truck. Yard derricks handle it directly from the trucks to the storage piles.

Arrangement of Pacific Yards

The layout of both the Portland and the Tacoma yards, which are similar, was the subject of careful study (see Figs. 5 and 6). In the center is a mill building, 500 feet by 200 feet, on the lower floor of which the following equipment is installed:

Five Fay & Egan band saws; 1 American 34-inch band saw; 2 American band rip saws; 1 Greenlee railway cut-off saw; 1 54-inch cut off saw.

Each of these saws is driven by a twenty-five horsepower electric motor.

On the upper floor of the mill building are the mold loft and the joiner shop, the latter equipped with the following machines:

One American 36-inch band saw; 1 American Variety saw, No. 10; 1 Hobbs pony planer; 1 Invincible buzz planer; 1 No. 2 American power chisel; 1 No. 3 American double spindle shaper; 1 wood lathe; 1 Pryibil swing saw; 1 American tennoning machine; 1 20 horsepower motor; 2 7½ -horsepower motors.

Adjoining the mill building is a two-story air tool house, 50 feet by 100 feet. The lower floor is devoted entirely to the storage of air tools, and the upper floor is equipped with saw filing and setting machines.

A wash room and locker building completes the group in the center of the yard.

The main office of the yard is in a two-story executive building, near the entrance, and there are a number of smaller offices scattered about the yard for the superintendents of different branches of the work. Near the main office a small building has been set apart for use as a hospital.

The riggers at each yard are given quarters where they can lay out their work on the second floor of a building known as the "sail loft." The lower floor of this building is used by the pipe fitters and painters.

There are also a fully equipped machine shop and blacksmith shop, where all repair work necessary to the yard equipment is done, as well as mechanical work connected with fitting up the ships.

Among the smaller buildings in the yards are: (1) copper and tinsmith shop; (2) pipe bending shop; (3) boiler house; (4) air compressor house; (5) punch and shear machine sheds; (6) Stetson-Ross planing machine sheds; (7) treenail shed and kiln; (8) strapping and bolting building; (9) storage shed for finished lumber; (10) 10 derrick hoist houses.

The foregoing description has applied in a general way to both yards, as the buildings in the Portland yard practically duplicate the hull yard at Tacoma. There are several additional buildings in the Tacoma fitting out yard, however, including a storage warehouse 50 by 100 feet and an exceptionally large spar shop.

As protection against fire, a high pressure pipe line has been laid out with numerous hydrants, supplied by motor-driven pumps. The fire marshal at each yard has a crew of trained men. The completeness of the system has caused the Insurance Bureau to give the Tacoma yard the lowest rating of any wooden shipbuilding plant on the Pacific Coast.

Even before the equipment of the yards had been completed, construction of the ships themselves was progressing rapidly, as evidenced by the photographs reproduced in Figs. 1-4. The panoramas of the Portland yard were taken at an interval of twelve days and those of the Tacoma yard at an interval of twenty-four days. Of the forty 3,000-ton wooden auxiliary schooners building at these yards for the French Government, fourteen have been launched and two have already completed successful trial trips. One of these vessels is shown in Fig. 16.

On April 30 a notable record was made at the Portland yard, where the keel of a 3,000-ton ship was laid eleven seconds after the launching of a hull from the same ways. This was accomplished by assembling the keel at one side of the blocks under the hull to be launched and moving it over into position as soon as the ways were cleared. Photographs (see Figs. 9 and 10) taken at the time show that before the spray raised by the launching had settled, the new keel had been trued up on the blocks.

The Foundation Company's Yard No. 5, at Savannah, Ga., was laid out for the construction of thirty-eight 150-foot steel mine sweepers, for one of the Allied Governments. According to schedule, keels were laid on May 20, and the company expects to deliver the first complete vessel in September. Provision has been made for adapting this yard to the construction of 10,000-ton steel steamers as soon as the present contract has been filled.

The Foundation Company has two additional steel shipyards, one at New Orleans, La., and the other at Port Huron, Michigan. The former is now being equipped to build five 4,250-ton cargo steamers of a new "unsinkable" type for one of the allied governments. The yard at Port Huron will construct ocean-going tugs, and steamers up to 3,000 tons deadweight.

Yard No. 6, at Brunswick, Georgia, has been located close to the Southern pine belt. The Foundation Company is building at this yard eight deck barges for the United States Navy, and two wooden ships for private interests.

At present The Foundation Company is employing in its shipbuilding department more than 9,000 men. Very little labor trouble has been experienced—on the contrary the men take great pride in the records which they have established for rapid and workman-like construction.

The Foundation Company was organized in 1902 by Franklin Remington and his associates, under the laws of the State of New York. Mr. Remington has been president of the company from the start, and, in 1914, John W. Doty was appointed general manager.

C. A. D. Bayley is vice-president, in charge of ship construction, assisted by O. F. Swenson, and C. I. Nielsen, naval architects, and by W. I. Bishop and Bayly Hipkins, managers of the shipyards on the Atlantic and Pacific Coasts, respectively.

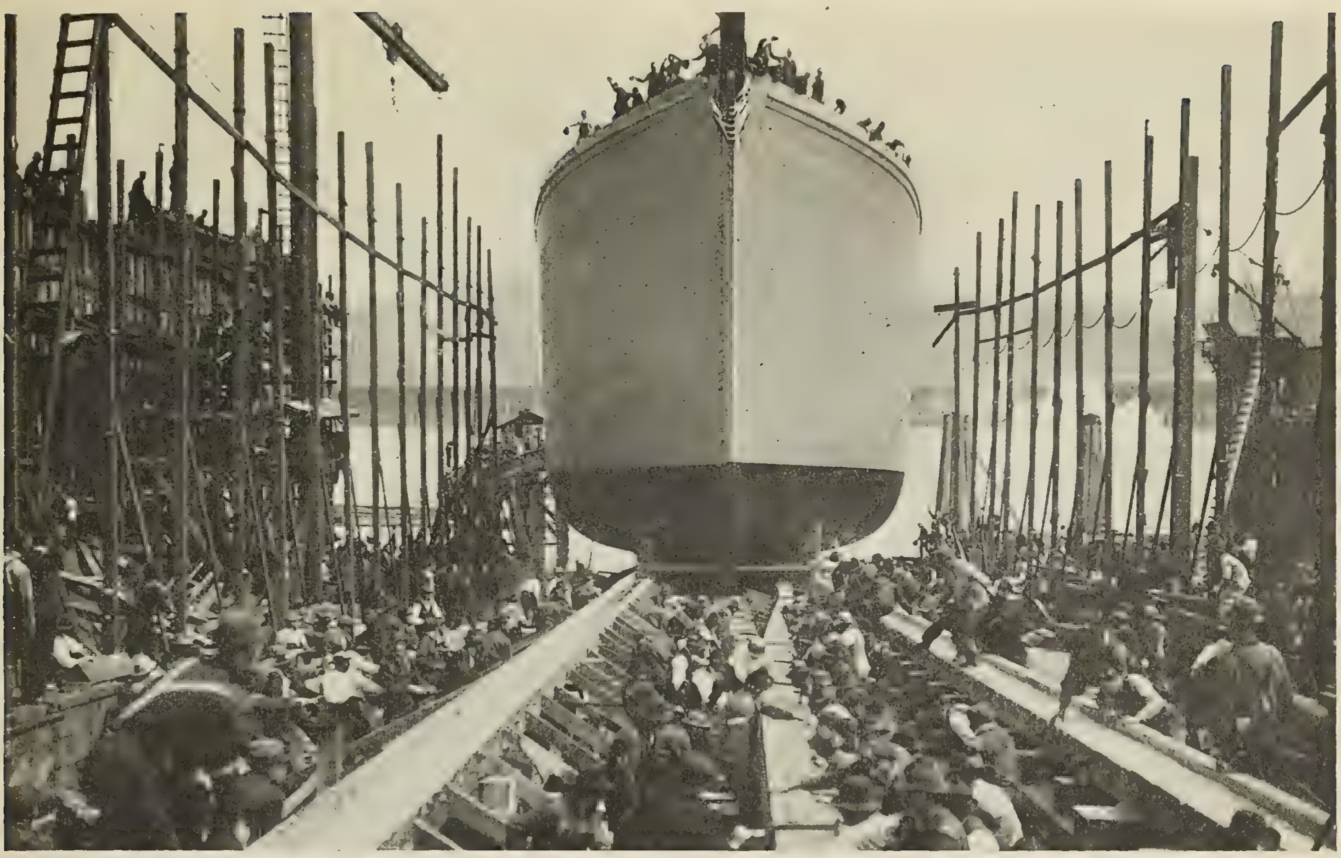


Fig. 9.—Launching of S. S. *Commandant Challes* at Portland Yard on April 30. New Keel Being Laid While the Vessel is Going Down the Ways

Fig. 10.—Keel Laid and Trued Up in Eleven Seconds After Launching Vessel from Same Ways

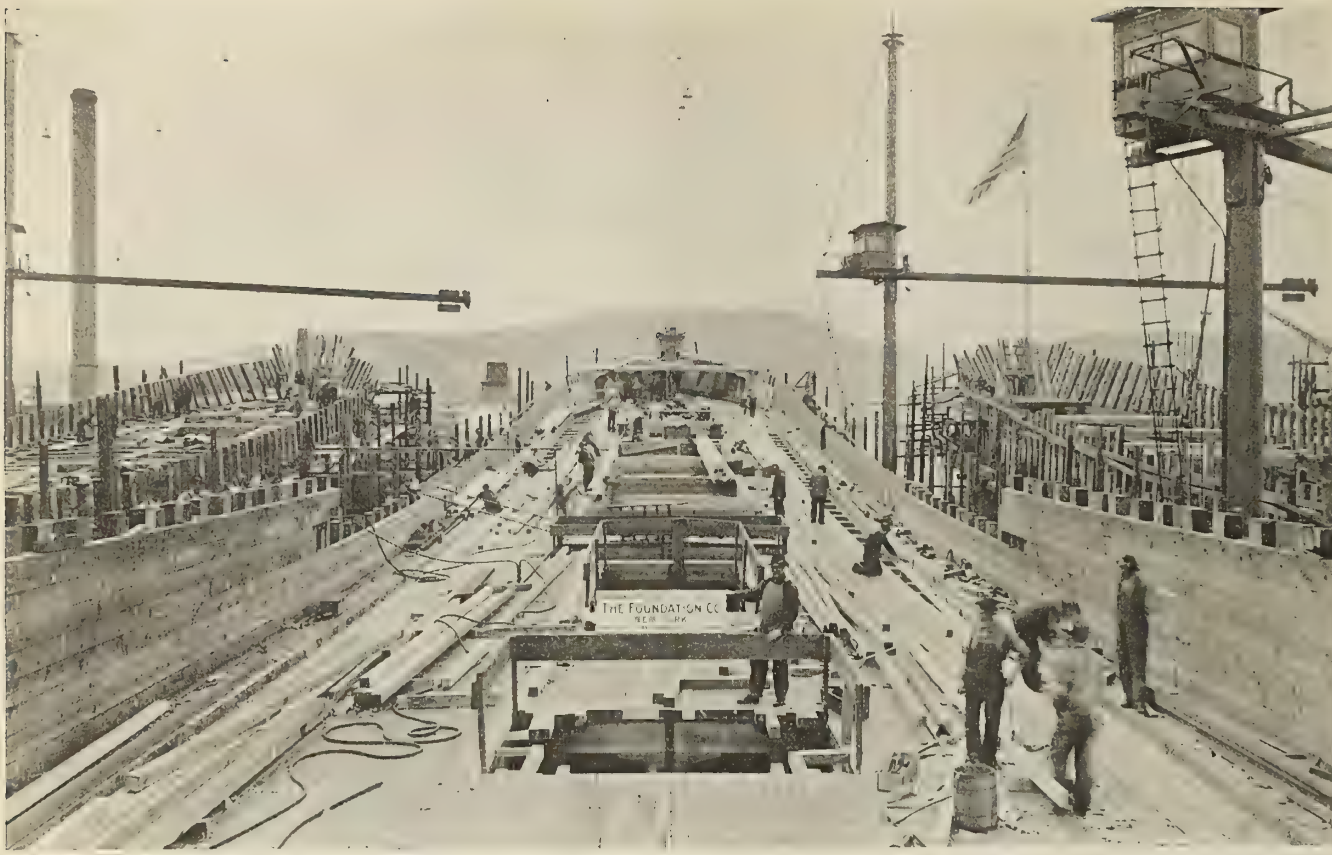


Fig. 11.—Progress of Work on French Ships at Portland Yard on May 16

Fig. 12.—Launching French Auxiliary Schooner *Lieutenant Granier* at Portland on May 11

Fig. 13.—Five Vessels at Fitting Out Berth of Foundation Company's Portland Yard on May 29

Fig. 14.—Section of Fitting Out Yard at Portland

(*Photograph by Underwood & Underwood, New York*)

Fig. 15.—Launching of the *Coyote* at Passaic River (N. J.) Yard of Foundation Company on March 19. The *Coyote* was the first Ferris Type of Wooden Ship to be Launched on the Atlantic Coast

Fig. 16.—The French Auxiliary Schooner *Gerbervilier* Starting on Her Trial Trip from Tacoma on June 1

Piping Arrangements Aboard Ship

BY ARTHUR H. BAKER

A SHIP'S piping system may be divided into two classes, and two separate working drawings should be made, showing each system independently. These are classified as follows:

1. Steam and exhaust piping.
2. Suction and discharge piping.

The steam and exhaust should indicate all such pipe lines to the main engines and to all auxiliary machinery, such as the auxiliary condenser, main and auxiliary feed pumps, circulating pump, fire and bilge pumps, evaporating and distilling plant, sea chests, heating system and any other auxiliary machinery necessary for the operation of the ship.

On cargo ships and transports having a direct route the auxiliary units are quite limited, while on naval vessels steaming to all quarters of the globe it is very advisable for installing additional units, as the evaporating and refrigerating plants, also additional pumps cross-connected in a manner that they may be used independently for pumping fresh or salt water to any desired location aboard ship.

Steam pipes are made of copper, wrought iron or steel. Small size copper piping is seamless drawn, while the larger sizes are made of sheet copper with brazed joints. Wrought iron pipes are lap welded, and steel pipes are made seamless drawn or solid drawn.

Copper piping is advantageous in many respects. It is bent very easily to almost any shape and worked into irregular forms as tees, elbows, etc.

While copper pipes are non-corrosive, yet they have the disadvantages of greater cost, low tensile strength and possible deterioration of the material in working to shape and loss of ductility from service.

Steel pipes are the reverse—purchased at low cost, greater tensile strength, and less likely to loss of strength in service.

Exhaust pipes are usually of copper, or brass screwed pipe.

The following formula is adopted for finding the thickness of copper and steel pipes:

$$\frac{P \times d}{8{,}000} + \frac{1}{16} \text{ inch for copper pipes}$$

and

$$\frac{P \times d}{10{,}000} + \frac{1}{16} \text{ inch for steel pipes.}$$

This applies to straight pipe only; the radius for bends should be not less than twice the diameter of the pipe, with thickness figured accordingly.

The main steam pipe leads from the boilers to the main engines (at boiler pressure), while the auxiliary steam piping leads from the boilers to all auxiliary machinery. The steam in this leaves at boiler pressure and by means of reducing valves is reduced to any pressure desired for running each auxiliary.

The exhaust piping from the main engine leads directly to the condenser or by means of suitable valves, cross-connected to the auxiliary condenser. As a general rule the exhaust from the auxiliaries leads through one common pipe to the auxiliary condenser, though in some cases it may be also cross-connected to the main condenser.

Sea water is forced through the condenser by the circulating pump, thus cooling and condensing the exhaust steam, which in turn the air pump delivers to the ship's feed tanks or back again to the boiler. It is very desirable to install a grease extractor on the feed line to the boiler, thereby removing any oil or grease that may have been collected in passing through the engines or condenser.

The suction and discharge pipes convey the water system of the ship and may be classed as follows:

1. Feed water from tanks to boilers.
2. Fire and bilge suction from sea to discharge on deck or overboard.
3. Circulating water, suction from sea through condenser, discharges overboard.
4. Fresh water system, from distillers to ship's fresh water tank or to the feed tanks.
5. All drains from traps, etc., to bilges or tanks.
6. Sanitary system for pumping salt water through ship's head.
7. Circulating water for distillers, suction from sea, through distillers, and discharging overboard or cross-connecting with the fire and bilge pump and discharging on deck, to be used throughout the ship in case of fire.

The above is a general description of the auxiliary piping arrangements. In the following we shall endeavor to classify and describe each system independently.

EVAPORATING AND DISTILLING PLANT

This system is used for obtaining fresh water for drinking and cooking purposes, also to make up for loss of water due to leakage. It is also used as a reserve supply to the feed tanks and boilers.

Sea water is steam-heated until converted into vapor and led to the distiller, where, coming in contact with cold circulating water, it is condensed, thus becoming fresh water. It is then discharged to the gravity tank, scuttlebutt or elsewhere as desired.

The evaporator is a cylindrical shell containing a nest of tubes. Steam passes through the tubes, while the water outside becomes heated and leads to the distiller, where, coming in contact with cold water, it is condensed and discharged and led to the trap and from here to the tanks.

The steam pressure on evaporator shells is figured at 50 pounds.

In a double effect evaporating system the vapor from one evaporator is used for heating the sea water in the other and is then discharged to the distiller; this is installed where two evaporators are used for the sake of economy.

The distillers should be located on the bulkhead or engine room hatch, as high above the evaporator as possible, thus preventing any salt to be carried up through the system with the vapor and getting salt water for the gravity tank.

The salt usually crystallizes in the bottom of the evaporator or on the tubes, and these should be scaled and thoroughly cleaned every week if possible.

(To be continued.)

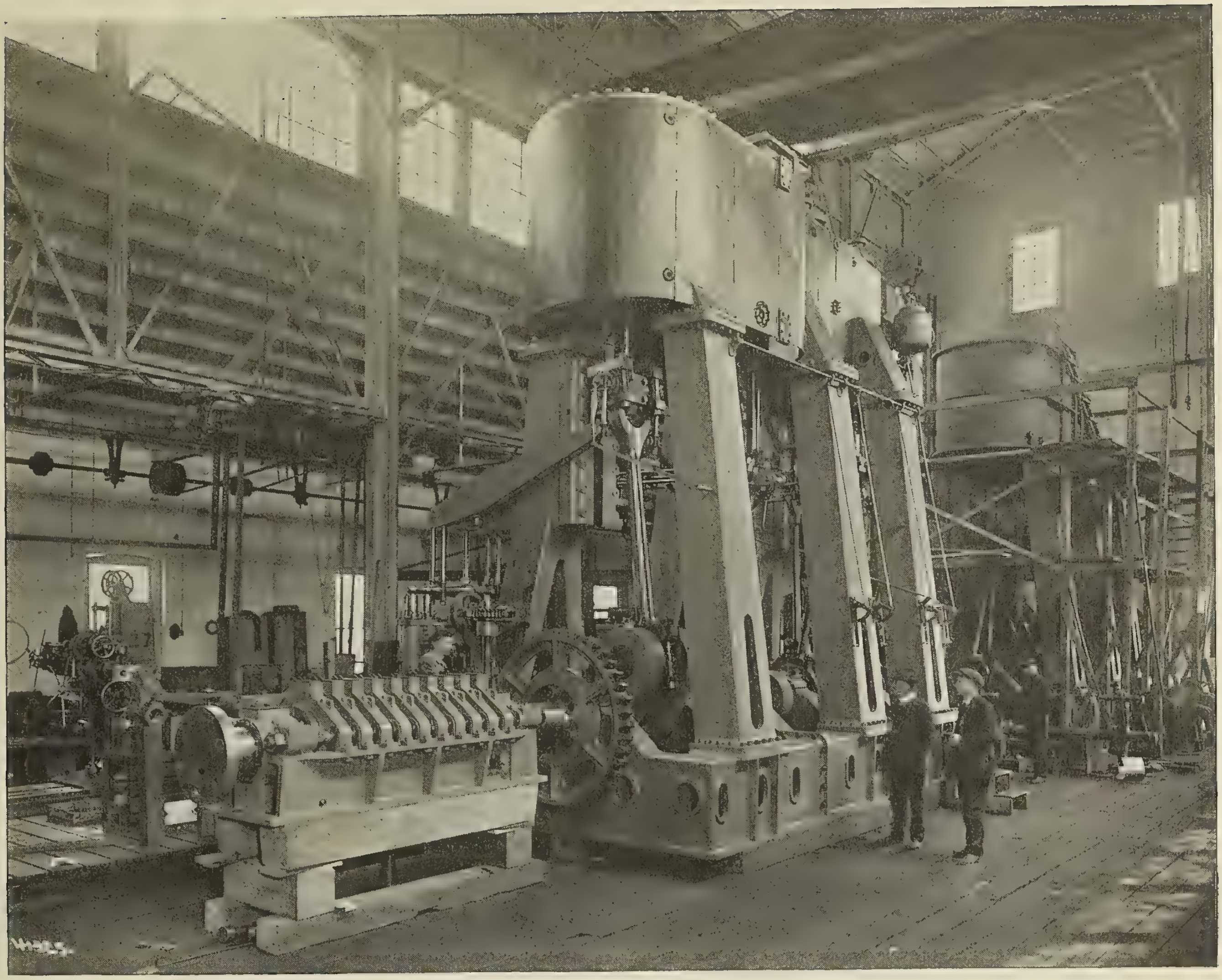
Everybody has seen the punch used in lacing belting. It seems strange that this idea has not been carried out on a larger scale by someone for cutting out holes in packing for studs and bolts.

Metal lagging on valve chests and cylinders will last much longer if given a coat or two of paint on the inside; it never rusts.

The smoother the surface of metal the less is the radiation of heat; that is why it is well to polish the pistons.

(*Photograph by Edwin Levick, N. Y.*)

Fig. 1.—Interior of Machine Shop, Showing Work on Engines, Propellers and Shafting



(*Photograph by Edwin Levick, N. Y.*)

Fig. 2.—Type of Reciprocating Engine Building for Vessels of the Emergency Fleet

Production of Propelling and Auxiliary Machinery for Emergency Fleet Must Be Speeded Up

DIRECTOR-GENERAL Charles M. Schwab of the Emergency Fleet Corporation has repeatedly emphasized the necessity for speeding up the production of propelling and auxiliary machinery for the Emergency Fleet. In an address before the annual convention of the American Boiler Manufacturers' Association in Philadelphia, on June 18, he stated that eighty or ninety hulls are now in the water waiting for their machinery equipment. The only true measure of the success of the shipbuilding programme is the number of ships completed and placed in service. So far the shipbuilders have achieved marked success in the construction of hulls. The shipyards are rapidly reaching a point where the production of ships' hulls is maintained at a satisfactory point. Due to the better distribution of material and the increased supply of plates and shapes, the hull work is rapidly outstripping the production of engines, boilers and other machinery.

Under the direction of Mr. Schwab the Emergency Fleet Corporation is definitely committed to the policy of extending existing facilities for ship production, and this means not merely the building of new ways for hull construction, but more especially the provision of additional facilities for building engines, boilers and all the accessories which are necessary for placing the vessels in active service. With additional facilities for this work it will be possible to get more ships per way in the existing yards, to say nothing of the correspondingly increased output from the new yards.

According to Mr. Schwab there is a fair outlook for boilers but the facilities for producing engines will have to be enlarged, especially for turbines and auxiliary equipment. Some idea of the immensity of this requirement can be gained from the accompanying views of a typical marine engine building plant which is now actively engaged in this work.

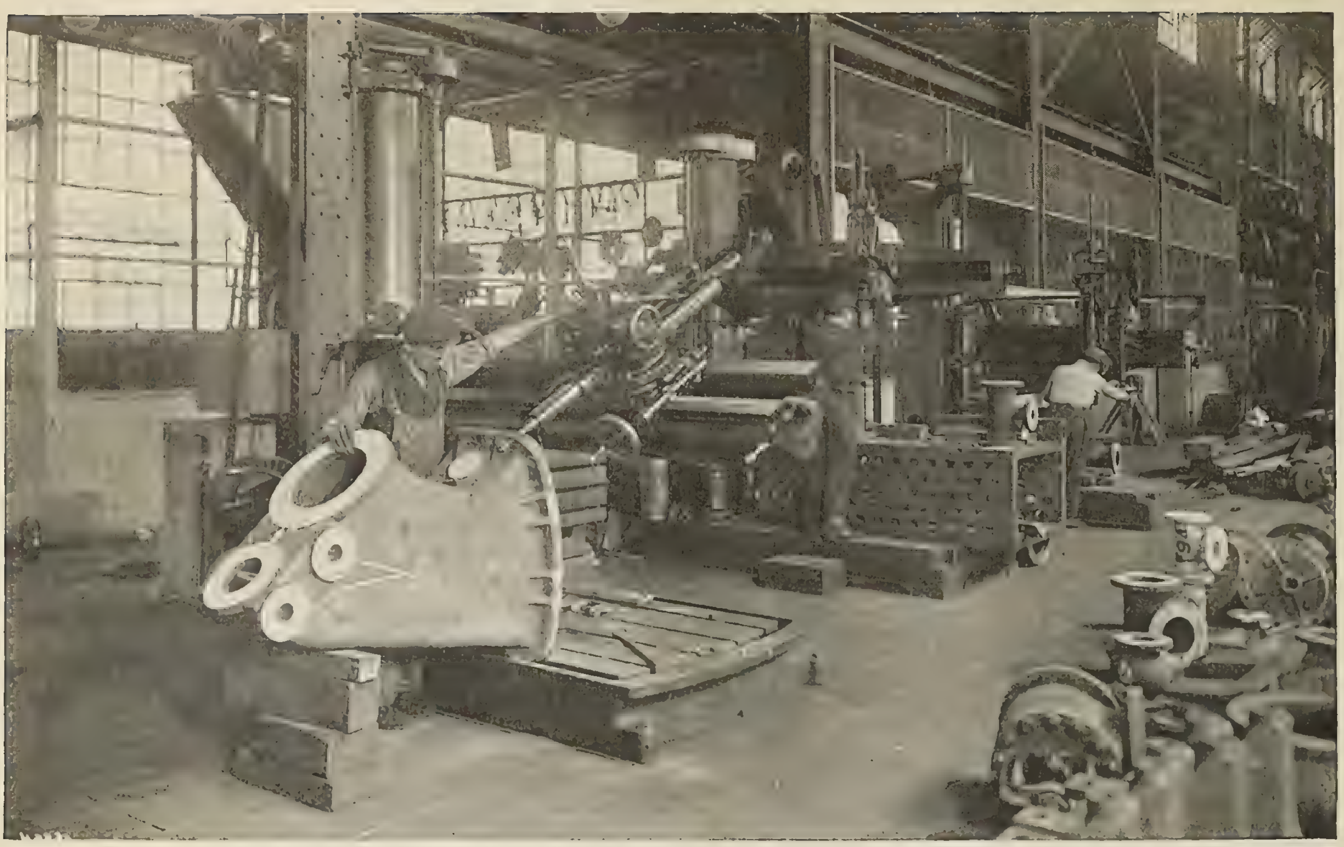


Fig. 3.—Drilling Castings (*Photograph by Edwin Levick, N. Y.*)

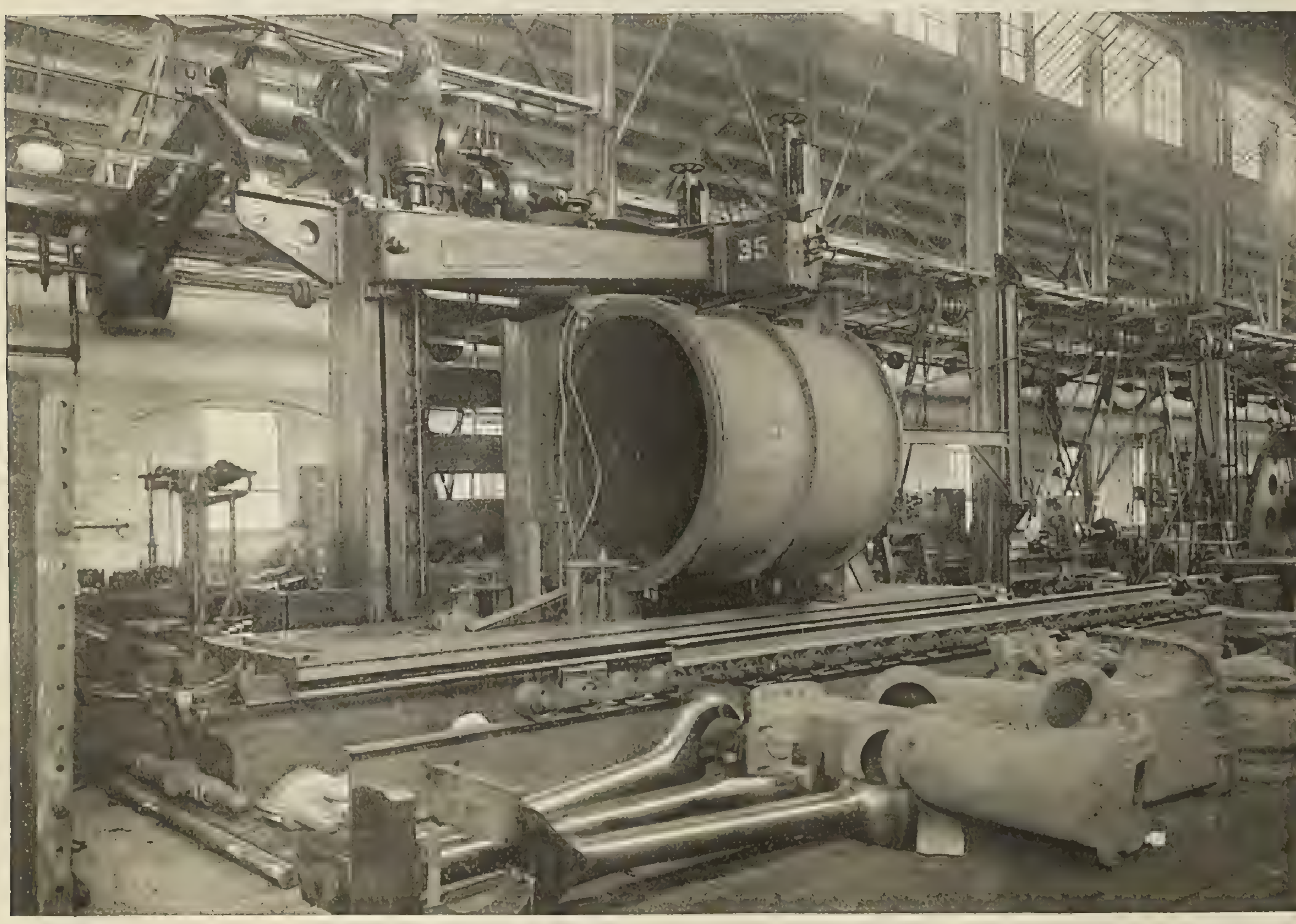
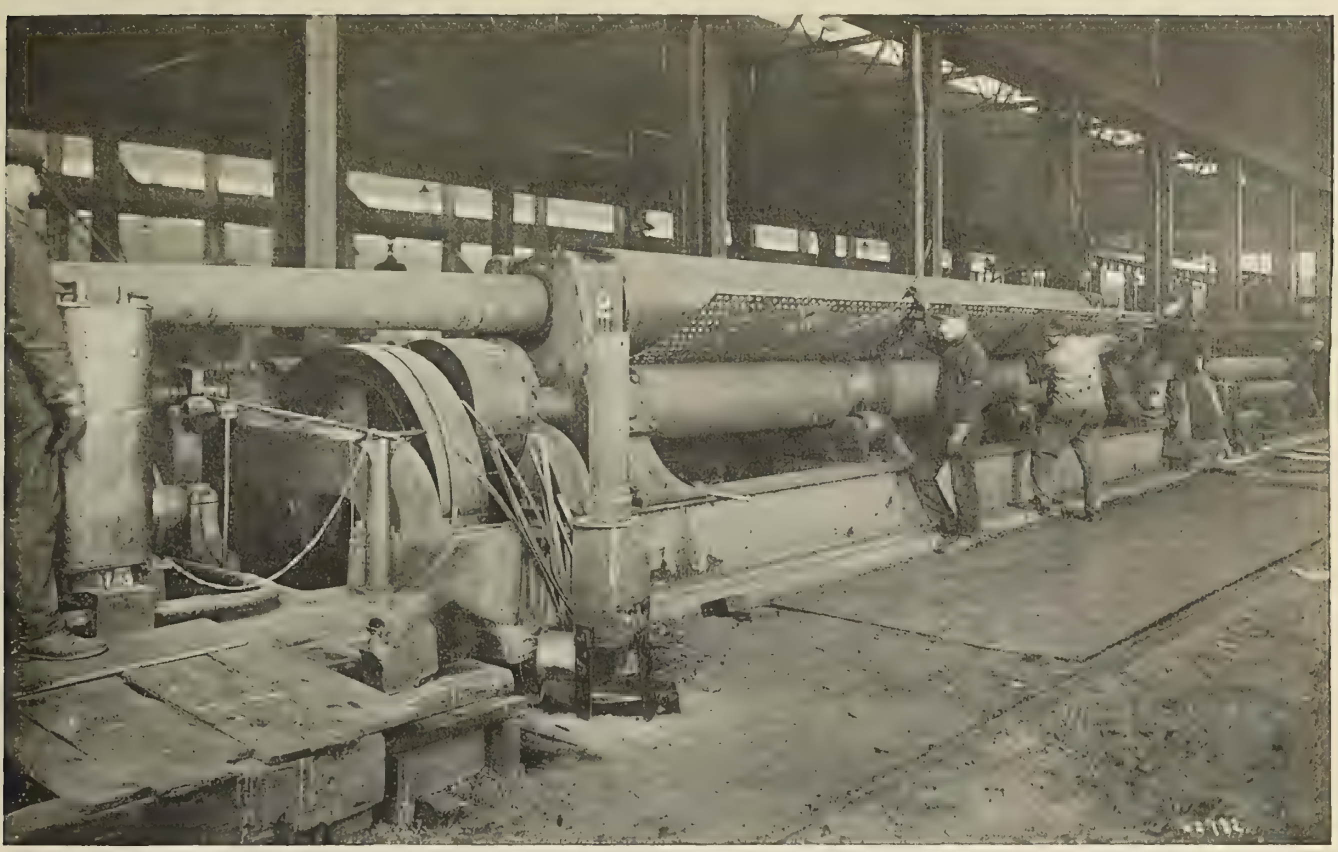
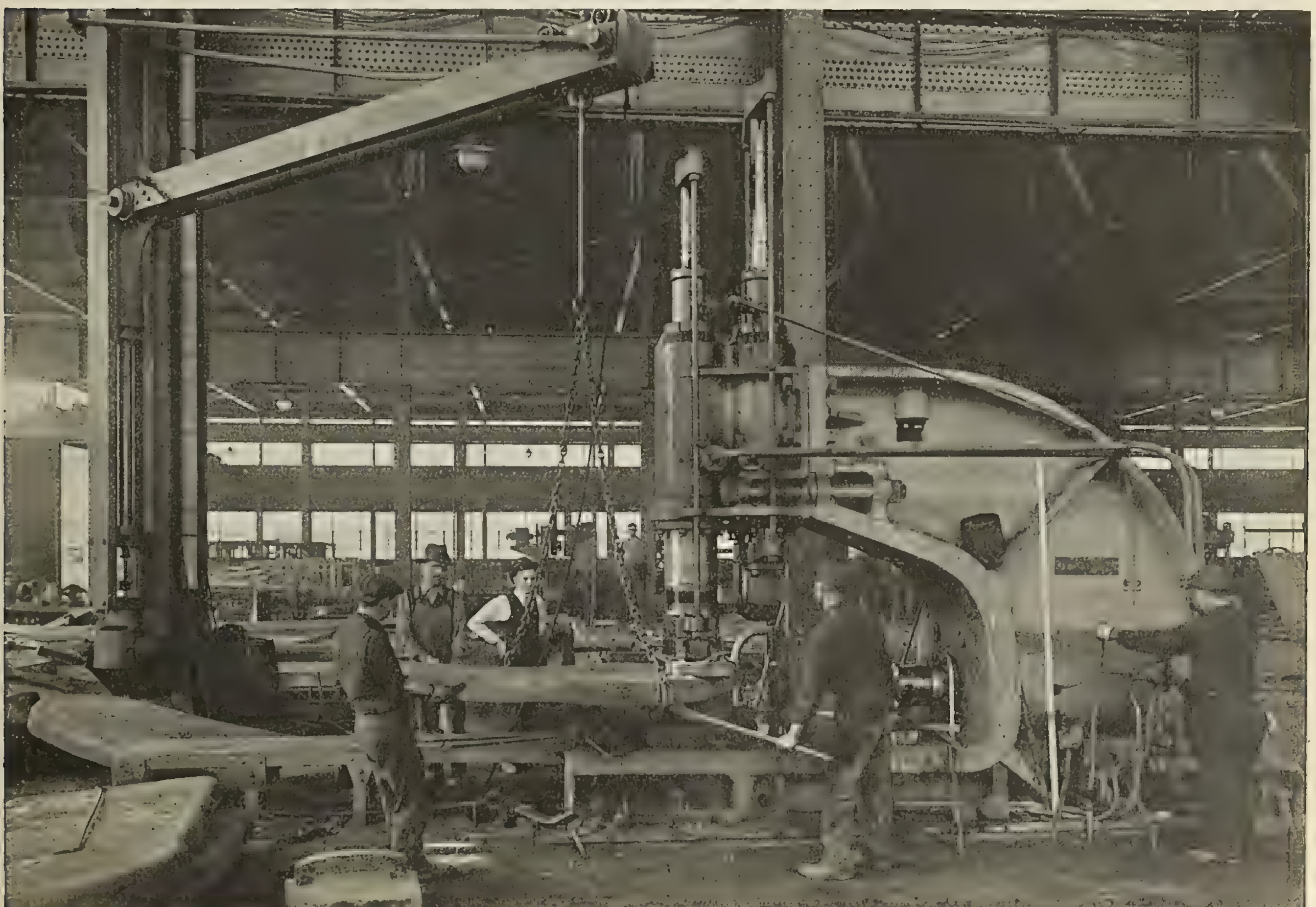


Fig. 4.—Machining Engine Cylinder (*Photograph by Edwin Levick, N. Y.*)



(Photograph by Edwin Levick, N. Y.)

Fig. 5.—Bending Plates After Punching and Shearing Are Completed



(Photograph by Edwin Levick, N. Y.)

Fig. 6.—Combustion Chamber Plates Formed on Hydraulic Sectional Flanging Machine

Motor Drive in Structural Steel Shop of Newburgh Shipyard

BY W. H. EASTON*

THE Newburgh shipyard is one of the shipbuilding plants that has been called into being by the war. A year ago its site was a marshland. To-day, on made ground that required thousands of cubic yards of fill, there are numerous buildings, four shipways and four large steel ships already under construction. The launching of the first of the standard 9,000-ton steel cargo vessels, on which this yard will specialize during the war, will take place next August and the other three will follow rapidly thereafter.

Of the various departments the structural steel shop is the one at present in most active operation, though all the others will begin work in the near future. The system of motor drive employed in this shop is of special interest at this time because it is a typical example of an emergency war installation.

Some of the conditions that had to be taken into consideration in laying out this drive were the following: (1) The machinery must be arranged to permit rapid and economical production. (2) The machines are to be handled by more or less unskilled men and hence must be safeguarded as thoroughly as possible. (3) Time is a vital factor; and as deliveries of special apparatus are nowadays very slow, the best possible use must be made of such equipment as can be obtained within a reasonable period of time.

As central station power from the Central Hudson Gas & Electric Company was available, it was of course used, thus avoiding the erection of an isolated plant, saving the labor to run it, eliminating the handling of fuel and ashes, and helping to economize coal. It was also decided to use individual motor drive throughout, in order to insure maximum output from each machine and to provide complete flexibility as to the arrangement of the machines in the shop.

* Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa.

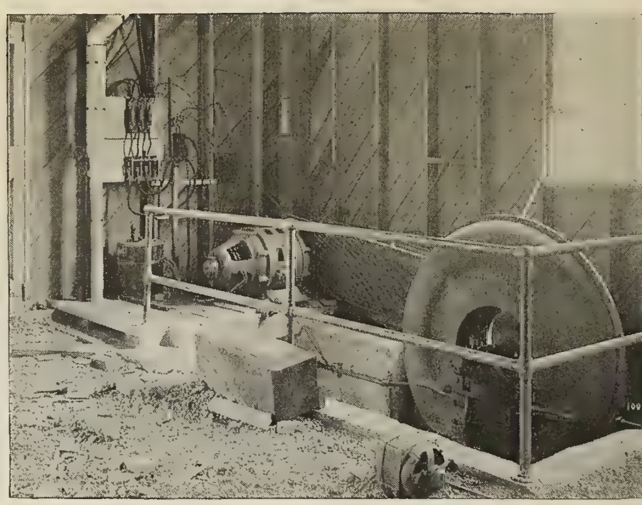


Fig. 2.—50-Horsepower, 870 Revolutions Per Minute Westinghouse Type C.W. Slip Ring Motor, Driving No. 10 Sturtevant Blower for the Crude Oil Plate and Angle Furnaces. Westinghouse Type MF Speed Controller

Alternating current only is supplied by the central station; and as practically all the machines in the shop (such as punches, and shears) are of the constant speed type, squirrel cage motors are used almost exclusively. The only exceptions are the furnace blower and the bending

Fig. 1.—General View of Hull Fabricating Shop at Newburgh Yard

Fig. 3.—Motor Drive Installed for Punches and Shears

rolls, both of which require speed variation. The furnace blower, which supplies air for the crude oil plate and angle furnaces, is driven by a slip-ring motor with a drum-type speed controller. The bending rolls were originally driven by a direct current crane type motor, which was supplied with current by a motor generator set; but as this equipment was decidely antiquated (war conditions making it impossible to secure modern apparatus at the time it was wanted), a variable speed alternating current motor is now being installed in its place.

As can be seen from the illustrations all the machines are belt driven. This is not the best possible practice, since, for such a machine as a punch or a shear, engineers usually favor mounting the motor on the machine and driving by means of gears. But this type of drive requires special machine work and a special high starting-torque motor, and would have added months to the delivery date of the equipment. Hence standard motors with belts were used instead.

High starting torque motors would, however, in any

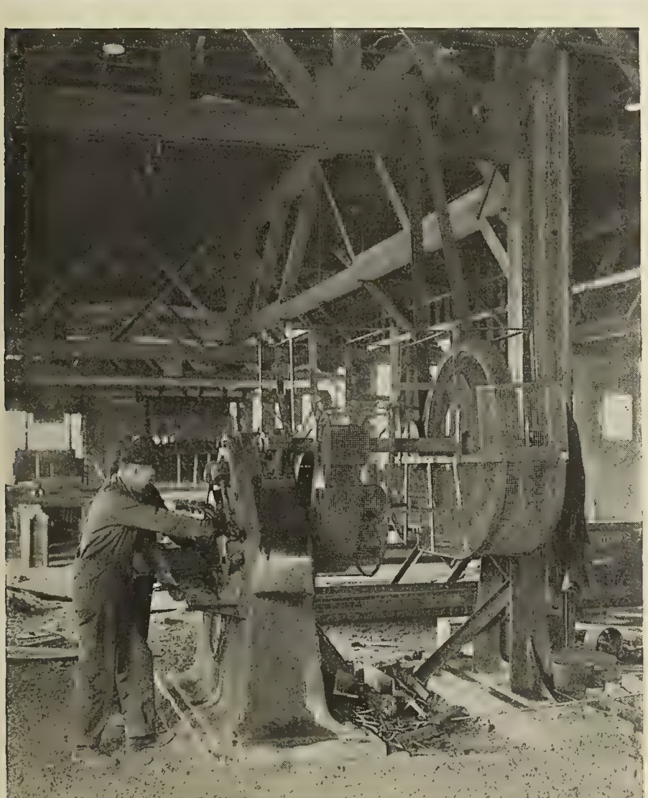


Fig. 4.—5-Horsepower Westinghouse Type CS Squirrel-Cage Motor Driving 6-Inch by 6-Inch by ¾-Inch Hilles & Jones Angle Shears

Fig. 5.—5-Horsepower Westinghouse Type CS Squirrel-Cage Motor Driving Hilles & Jones Horizontal Punch for Punching ⅞-Inch Holes in ⅞-Inch Plates. Westinghouse Type A Auto-Starter

case have been desirable for driving these ponderous machines with their considerable flywheel effect, but it was thought that the belts would slip enough in starting to relieve the motors of the excessive stresses that occur at this time, and experience has proved this to be the case, since none of the motors have given trouble. This good record has been especially gratifying to the engineers in charge of the installation, since time did not permit a power test to be made of each machine and the motors were selected largely by judgment and the supply of motors available for early delivery.

All belts, pulleys, and gears are carefully protected by wire metal screens, and all motors that are started and stopped by the steel workers are controlled by means of auto starters or oil switches which have no exposed live parts and cannot be improperly manipulated by even the most careless person. Automatic protection against overloads and failure of power is also provided.

Fig. 6.—5-Horsepower Westinghouse Type CS Squirrel-Cage Motor Driving ⅞-Inch by ⅞-Inch by 30-Inch Hilles & Jones Vertical Punch. Westinghouse Type A Auto-Starter

The current from the central station is received at 5,700 volts. A small sub-station in the shipyard, consisting of a bank of transformers and a panel carrying the necessary switches and meters, reduces the voltage to 220 for use around the plant.

A Breakdown Aboard Ship

The following account of a breakdown which happened to the engines of a steamer on which I was chief engineer may be of interest in view of the active interest being taken in marine engineering at the present time.

We left Rotterdam (pre-war days) with a cargo of coal and proceeded down the river, everything running smoothly and well. Shortly after we had dropped the pilot and were heading at full speed for the Straits of Dover, a tremendous bumping caused me to rush to the engine room, where the second engineer already had the engines stopped. It had all happened so suddenly that there was no chance to locate the cause of the trouble, and nothing unusual showed to give us a clue. Being satisfied that something was wrong inside one of the cylinders, we proceeded to open them up. Their dimensions were: High pressure, 25 inches; intermediate, 41 inches; low pressure, 67 inches; stroke, 45 inches. As far as the second engineer could judge, the noise came from the intermediate cylinder, but on opening it we found it in good condition. On opening up the high pressure cylinder, however, we found a sorry mess; the piston was smashed into "a thousand and one" pieces, caused by one of the junk ring bolts breaking at the end of the thread. There being insufficient clearance between the piston and cylinder cover, something had to go, and apparently the piston was the weakest part. Fortunately, after a few strokes the broken bolt got opposite one of the core plugs on top of the piston, and on the next stroke the core plug was forced in and the broken bolt jammed in the hole, thus preventing any further damage.

Running on Two Cylinders

To operate the engines as a triple expansion set was out of the question, so we made ready to run on two cylinders. The pieces of the broken piston were removed, but the piston rod with the crosshead and guide shoes was left in place, the piston rod thus serving to keep the gland steam-tight. With the piston valve and valve gear removed and the covers replaced, we were ready to proceed. The boiler pressure was reduced from 175 to 100 pounds. No trouble was experienced in starting the engines, and we headed for Deal, where we could report the accident to headquarters. Orders were received there to proceed to Plymouth where a new piston would be sent us.

The trip down the English Channel was uneventful though somewhat slow, but the engines gave no trouble, even though they were somewhat out of balance due to the cranks being at 120 degrees. The coal consumption on the "pounds per indicated horsepower" basis was largely increased, but that was to be expected with a reduced initial pressure and the consequent reduction in the number of expansions by the loss of one cylinder. The limits of the valve gear prevented us cutting off early enough in the new high pressure cylinder to give the previous ratio of expansion.

Straightening the Piston Rod

On arriving at Plymouth, the first job was to get the piston rod out to find out whether it had become bent in the smash. The limited means we had on board ship for testing proved that the rod was damaged, so it was sent ashore to a repair shop. When placed in the centers of a lathe, a double bend was found at the tapered part which fitted into the piston. The straightening of the rod, which was 6⅜ inches diameter, proved to be a difficult job, but by means of a charcoal fire, wooden blocks and mallets the blacksmith managed to get it nearly true and comparatively free from marks and scaling. When tested in the lathe again, only a slight cut was required to bring the tapered part true. This allowed the piston to go ⅛ inch farther on the rod, but there was sufficient clearance in the cylinder to allow for this.

Having got the new piston fitted to the rod, no time was lost in having it placed on board, where everything was ready to handle the job with dispatch. It was 2 p. m. when the piston and rod were on deck, but we were ready to sail by 10 p. m. On the voyage out and home again

no defects developed, and so far as I know the same engines are doing duty still.

Some of the things we did, or rather the things we omitted to do, in connection with this job are open to criticism, such as neglecting to close up the steam ports in the high pressure cylinder and not changing the cranks to 90 degrees; but the distance we had to travel to the nearest port was not great, and we were anxious to get under way again in the shortest possible time.—*John Melville, in Power.*

What Women Are Doing in the Shipyards and Shops in Great Britain

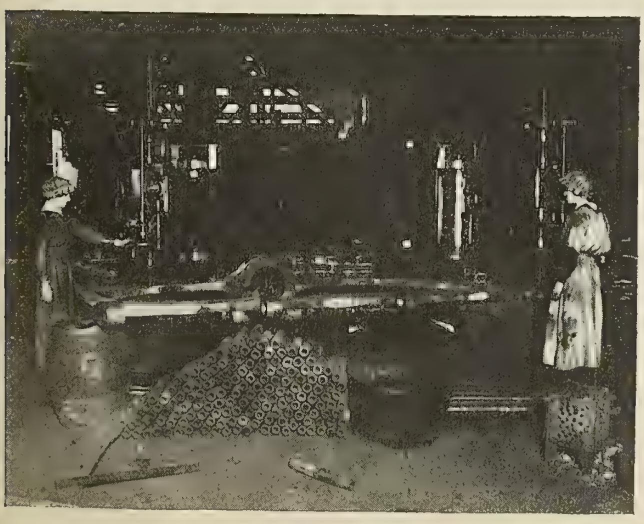
In a recent issue of the *London Daily Chronicle*, a correspondent has the following to say regarding the work women are doing in the the shipyards and marine engineering shops in Great Britain:

The tasks women are doing in and about the yards and marine engineering shops are innumerable. That fact tempted an engineer to say two years ago that by 1918 women would be able to build a battleship from keel to aerials. Too optimistic a statement, maybe, but let us consider for a moment what they have actually done.

Work in the Shipyards

I have before me a carefully compiled record of the multifarious jobs being done, and well, by women in and about shipyards and marine engineering shops. Before setting them down I will quote the words of an eminent Scottish shipyard expert: 'Strength and endurance alone prevent women from doing all the jobs. They are intelligent enough—more intelligent than many of the men; they work hard; they don't get 'fed up' with doing the same job constantly. Give them a repetition job that makes good pay and they will go on with it week after week—quite happily. But there are jobs they cannot do: heavy riveting; working up to their knees in water and mud, repairing the keel of a ship, moving ships about the yards, and so on.'

On board ship, women are fitting electrical apparatus for yard lighting, mains and telephones, and doing complex wiring work generally. Also they are chipping, scraping and painting (doing dredgers and steam hoppers externally and internally). In the yards they are hydraulic riveting, scraping and coating the bottoms of destroyers and submarines, driving cranes (some of 50 tons). French polishing, laboring (carrying 60-pound weights singly), loading into wagons and barges, cleaning and painting chain cables.



(Photograph by Press Illustrating Service, Inc., N. Y.)
Women Operating Radial Drills in Drilling Stern Frame

(Photograph by Press Illustrating Service, Inc., N. Y.)
Women Scaling Bottom of Vessel in Dry Dock

In the workshops in or near the yards they make and repair the overalls and 'Fearnought' clothing, make flags and sails and do upholstery. Many had thought that wood-working machinery ran at too high a speed for women, but women are operating machines for wood planing and for making wooden boiler tube plugs.

In the Engineering Shops

The engineering shops find them work on 6-inch and 8-inch slotting machines, horizontal and vertical drilling machines, and turret and capstan lathes (non-repetition work in very many cases and the women setting up their own tools). One woman, said to be able to turn her hand to any job, operates a radial turret drilling machine with capstan head which performs six operations. Overhead cranes are driven by women, and one woman drives a traveling jib crane among the small lathes. They are generally employed on radial and sensitive drills and milling machines, and turbine blades are made and assembled by them. Women are also acetylene welding, nut facing, and acting as plumbers' assistants. In the foundries they are machine molding, core making, grinding, packing, and sorting.

The boiler shops find them work drilling, boring, turnings, slotting, helping light platers, painting, assisting with rivet machines, pickling boiler tubes, cutting tubes, removing burrs from tubes and plugging them, and turning tube expander mandrils. They are fitting and filing pipe and valve flanges, filters and valves, and bending superheater tubes. They are constantly working in the rigging house on wire ropes of 1½ inches, and have done 2 inches. In the braziers' shops they are repairing lamps and soldering.

Of the more readily suitable jobs, such as tracing, storekeeping, time-clerking, scutching and spinning fibre in rope shops, looking after switchboards in generating stations, and lacquering, there are a great number.

All these are not jobs ideally suited to women. That the women are doing them, and, on the whole, well, is sufficient tribute to their fearless adventuring on any task open to them, to their inspiring industry, and to their great and whole-hearted championship of the cause of humanity—the Allied cause.

Oil- and Water-tight Joints in Ships' Hulls

Effective Methods of Securing Water- and Oil-Tight Joints in Ship's Structure Under Different Conditions

By Evers Burtner*

MORE than ever before the ranks of draftsmen are being recruited from technical school graduates, or others who have had little or no practical shop experience. This is a decided handicap both to the men themselves and to the yards in which they may serve. These men should welcome every opportunity to learn the reasons for various practices employed by questioning the leading men of the plant, by careful study of standard treatises on ship construction† and the pertinent articles which have recently appeared in Marine Engineering. My own experience has been that the average leading man or skilled workman is only too glad to give his reasons for the various methods he uses to secure the best results. In the present paper, I aim to give a brief description of some of the more effective ways in which water- and oil-tight joints may be secured under different conditions.

There are three chief methods used in producing watertight joints, viz.: by welding, by calking and by packing or gaskets. Of these, welding, it seems to me, holds much promise for the future, since its general use would relieve us of the trouble of calking and punching. It is well to remember, however, that a welded joint does not have 100 percent efficiency any more than a riveted one. An account of some tests made of oxy-acetylene welds showed that the tensile strength of the joints approached the strength of the remainder of the metal (about four-fifths of the latter), but its ductility was very low. This is due to the fact that the metal at the weld does not receive the same treatment as the rest.

Calked Joints

Calking produces a watertight joint by forcing the edge of one plate hard up against the other. The spring-like property of the calked plate causes the joint to remain watertight, as shown by Fig. 1. Lap calking is more common than butt calking and is preferable from the point of view of tightness and ease of production. The tools used are the splitting edge or maker, the reeding and the butt tool. For a lap joint, the splitting tool would first be employed to cut a groove. This is followed by the edge tool, whose function it is to force the lower edge of the lapped plate against the other. If the groove is about 3/16 inches above the faying surface, and the inspector cannot insert his testing knife, the calking is considered satisfactory until otherwise tested. In a butt joint, after cutting grooves ¼ inch from the ends of the two plates, the butt tool may be used to finish the operation.

The following axioms concerning calked joints should in general be true:

A calked joint ought to form a complete circuit, and therefore no discontinuity in the calking edge should be allowed. An example of this is the bulkhead boundary bar.

As a rule only one side of a watertight or oiltight division is calked, and the more accessible side should be chosen. However, where two adjacent compartments are to be tested, both sides of the bulkhead may be calked so that leaks can be readily "touched up" under test.

Angles or flanged plates bounding a watertight or oil-tight compartment should face, if possible, so as to allow calking while the compartment is under test. Flanged plates which are to be calked require special attention, since, of course, only the edge can be so treated.

In three- or four-ply work the watertight thickness preferably should not be the central one.

Stiffeners, when possible, ought to be placed on the non-calked side. If this plan is followed, simply calking the rivet heads will produce watertightness. When for any reason stiffeners are used on the calked side these as well as the rivets may require calking.

To prevent drain water from causing rust streaks it is often necessary to employ watertight rivet pitch and calking in a joint which otherwise might not require this.

Riveting

Rivets are commonly not calked even where the seams are, unless special tightness is required, as in oil tanks. Countersunk rivets can readily be calked, and, therefore, countersunk heads and points should be used where the plating is reasonably thick, and if both sides of the tank should need calking under test. Pan head rivets can be calked, but are to be avoided when possible, wherever the calking of rivets is needful. Because of their hardness, nickel steel rivets are difficult to calk successfully.

Some insurance companies require that oiltight rivets be ¾ inches or more in diameter. Where two plate edges of unequal thicknesses are connected, the thinner plate naturally determines the size of the rivets.

The pitch of the riveting in plates varies from three to four diameters for oiltight joints, and four to five diameters for watertight. Boundary angles and staples may have a slightly greater rivet spacing. In boundary bars, where two rows of rivets are used in each leg, the pitch of rivets next the heel is sometimes made just twice that of those next the toe. Staggered or zigzag riveting is often employed for boundary bars, stiffeners and bracket plates; elsewhere chain riveting is customary. It should be remembered, however, that these rules are not ironclad, and in special cases the pitch of a few stray rivets may be a diameter or so greater when the plating is reasonably thick. The lap of the plate is from one and a half to one and five-eighths the rivet diameter.

Plating

As a rule, 3/16 inches is conceded to be the thinnest plating that can be conveniently calked; any thinner plating is usually made water- or oil-tight by packing or welding. In the best class of work, all plate edges are planed before calking, to make sure that the rough edge left by shearing is removed. Furthermore, the rivets should be punched from the faying surfaces so that there may be no rag left on the edge of the hole to prevent the joint from being bolted up tightly, and also because the hole on the die side of the plate is greater in diameter.

Joggled plating or boundary bars require that a scrap of steel ("Dutchman"), be driven in to produce water-

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* Instructor in Naval Architecture, Massachusetts Institute of Technology, Cambridge, Mass.

† Holm's "Practical Shipbuilding."
Hovgaard's "Structural Design of Warships."

or oil-tightness (Fig. 2). A tapered or an ordinary liner for "in and out" plating is a legitimate method of avoiding this.

The relative efficiency of the end connections in plating as regards calking is according to the following order: butt lap, double butt strap, single butt strap.

Butt Laps

Where three plates come together, as at the intersection of a butt lap and an edge seam, the wedge-shaped hole

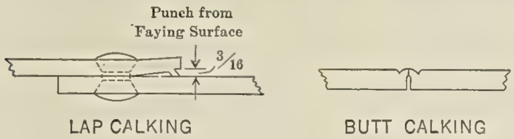


Fig. 1

Fig. 2

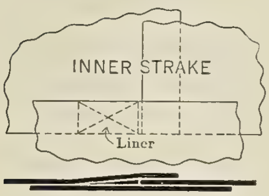


Fig. 3

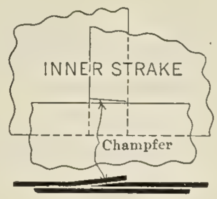


Fig. 5

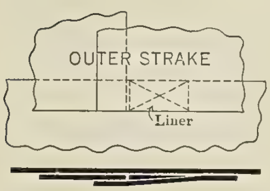


Fig. 4

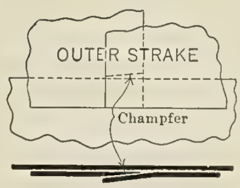


Fig. 6

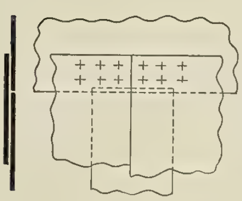


Fig. 7

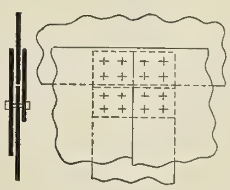


Fig. 8

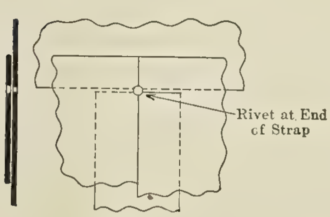


Fig. 9

occurring at such a point must be filled. The ordinary plan is to use a tapered liner, as shown in Figs. 3 and 4. The liner should be long enough to take at least three rivets.

Instead of using a tapered liner the edge of the plate may be chamfered (Figs. 5 and 6). It is sometimes considered best to chamfer the inner strakes and use tapered liners for the outer.

Single Butt Straps

Because of the nice fitting required of plates meeting at the butt joints, and the greater trouble in calking, the use of lap joints is to be preferred. With the increase in the length of shell plates it becomes more difficult to make the edges meet closely enough for satisfactory butt calking. Where the butt straps run the full width of the butted plate, as on the inside strakes of the shell, the calking is not troublesome. But for the outer strakes, where the butt strap is stopped short of the inner plate

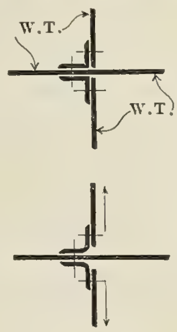


Fig. 10

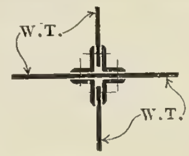


Fig. 11

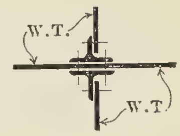


Fig. 12

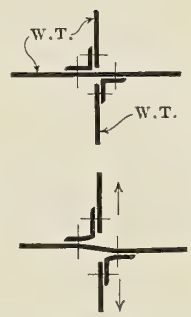


Fig. 13

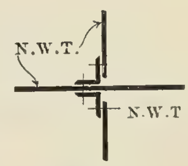


Fig. 14

edges, any one of the three methods indicated in Figs. 7, 8, 9 may be employed when an absolutely tight joint is required. Fig. 9, no doubt, presents the simplest plan, while Fig. 7 illustrates a method similar to the one employed for the butt straps of boilers and is the most efficient.

Angles

The thickness of the leg of an angle should be 3/16 inches or more, for satisfactory calking. To get rid of the round at the toe, the calking edges are invariably planed or chipped, and this is usually best done before bolting in place. Where it is necessary, the heel of an angle may also be calked, but this is likely to be less efficient and should be avoided whenever possible. If it is considered advisable to calk both sides of an oiltight floor with a single boundary bar, the edge of the plate may be calked against the angle before erection. Bracket plates landing on oiltight bulkheads often have double angles to provide a stronger connection than the single angle affords. A "T" bar from the standpoint of calking is to be preferred. A comparatively thin bulkhead can be made watertight by the use of two boundary bars, one of which may be calked, and the other will prevent the bulkhead from deflecting away from the calking angle. Nevertheless, it should be borne in mind that if the plating springs away from the boundary angle it will hardly be stiff enough at the seams.

Disposition of Angles

Where strength of structure, together with watertightness is necessary, Figs. 10, 11 and 12 illustrate the

customary layouts. Fig. 10 requires less riveting, but is weaker than the other two schemes, and deformation is likely to take place as suggested in the sketch. For oiltight work, Fig. 12 indicates the best plan to be followed, since it has less three-ply riveting. But all of these methods of construction involve three-ply riveting, and therefore packing may be necessary.

If watertightness is of first importance, and strength merely secondary, the scheme in Fig. 13 would better be followed. But under strains this construction is less dependable than the previous ones, as our sketch illustrates.

In passing, we may remark that with non-watertight work, and where strength is fairly important, three-ply riveting, as indicated in Fig. 14, would be preferable to reversing the angles. This would dispense with one row of rivets, and three-ply rivets with careful loft work and punching would not be objectionable.

Staples and Boundary Bars

With channels the stapling is quite complicated. The inexperienced draftsman should remember that it is necessary to cut a rectangular hole in the plating in the way

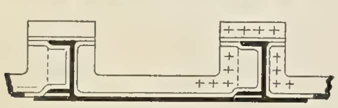


Fig. 15

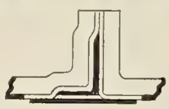


Fig. 16

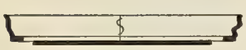


Fig. 17

Fig. 18

Fig. 19

of the channel, as in Fig. 15. This calls for welding a piece in the boxed end of the channel to take rivets, as indicated. The difficulty in forging staples has led to the suggestion that they should be standardized, and made of steel castings or machine-forged pieces.

When staples are required around bulb angles, the best practice is to chip away the bulb in order to simplify the smithing. It may be worth while, also, to remove the outstanding flange of a channel in the same manner, if at this point the additional strength it contributes is not greatly needed.

Joints of Boundary Bars

Three possible cases occur in this connection. If watertightness is of primary importance and strength only secondary, we may let the boundary bars merely butt neat and calk the butt. However, if watertightness and strength are both very necessary, a bosom piece, fitted as in Fig. 18, would be employed. Such a piece must be planed on its heel, and usually on the toe also. Where strength is the first consideration, and watertightness is of minor importance, the heel piece (Fig. 19) is best.

Castings

It may be necessary at times to calk castings riveted to the shell or deck. Cast steel of 60,000 pounds per square inch tensile strenth or less can be readily calked. Manganese bronze also will generally admit of the same treatment.

Clearance in the Way of Calking Edge

A single case illustrating the need of sufficient space to calk properly is the postion of the waterway angle, clear of the stringer angle. Bracket plates should be sniped ¾ inches or more clear of the toe of the angles requiring calking, as indicated in Fig. 21. It goes without saying that this rule should be carefully followed. Sometimes this loftsman must call for a countersunk rivet in place of the ordinary pan head when the rivet head interferes with the calking of the seams.

Places Requiring Packing

Packing should be employed where calking alone will not produce watertight or oiltight joint, as for example where a watertight division is pierced by structures, or in three- or four-ply riveting, especially when the center thickness is watertight. The intersection of a frame with a deep tank top may be cited as a familiar example of a watertight division pierced by structure. Since we cannot be sure that the frame bears hard enough against the shell to prevent a leak at this point, we may provide against this danger, either by placing a small piece of packing, as indicated in Fig. 22, or a thread stop-water may be laid along line *A B*, Fig. 23, and the toe and heel calked up to this point.

Fig. 20

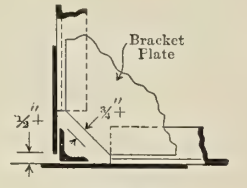


Fig. 21

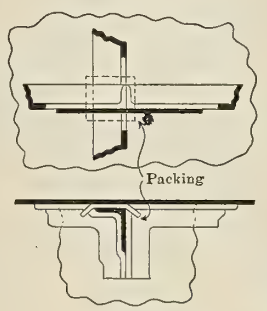


Fig. 22

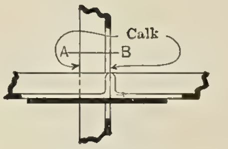


Fig. 23

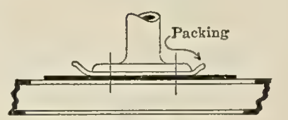


Fig. 24

As examples of three- or four-ply riveting, where packing is needed, we may point to the following two cases: A stop-water would be placed under the foot of a stanchion fastened to a watertight deck in the way of the deck beam (Fig. 24). Three-ply rivets in a joint whose central thickness is an oiltight division will usually be packed.

Materials for Packing Joints

For packing watertight joints, canvas soaked in red lead is ordinarily used. Lampwick, felt, or even paper dipped in red lead, tar, or white lead, may be employed.

For oiltight packing, felt or canvas soaked in a mixture of pine tar and shellac may be used. While red lead is sometimes employed for this purpose, it is likely to be dissolved by the oil.

A red lead gun may be used to force red lead into seams which give trouble in calking.

While books on ship construction treat in some degree certain aspects of the subject covered by these notes, they are not available in convenient form, and the writer believes that the concise manner in which they are here presented will not be without value to an increasing number of men who are devoting themselves to the various processes employed in ship construction.

Standard Cargo Ships*

British Practice in the Design and Construction of Standard Cargo Ships

BY SIR GEORGE CARTER, K.B.E.†

THE object of the paper is to place on record the advantages of standardization in the construction of cargo vessels as a war measure, and to give some account of the work of the Advisory Committee on Merchant Shipbuilding in the design and construction of what are now known as "Standard Ships."

In December, 1916, the New Ministries and Secretaries Act was passed, which provided for the appointment of a Shipping Controller. The Act gave this Minister wide powers and provided that he should "take such steps as he thinks best for providing and maintaining an efficient supply of shipping." Sir Joseph Maclay became the Shipping Controller, and the Government decided at once that merchant shipbuilding should be under his control.

Merchant Shipbuilding Advisory Committee

In December, 1916, after a conference with shipbuilders and marine engineers, Sir Joseph Maclay appointed the Merchant Shipbuilding Advisory Committee, of which I had the honor to be chairman.

The first meeting of the committee was held on December 20, 1916, and after fully considering the whole question it was decided, in collaboration with the Shipping Controller and his other advisers, to proceed at once with an extensive building programme of cargo ships of simple design and, as far as practicable, of standard types, both with respect to engines and hull. Although the Government's shipbuilding programme gave standardization in shipbuilding concrete form on a large scale, standardization had been widely discussed and urged as a practical policy both in regard to hull and machinery, and had in fact taken definite shape on a smaller scale by individual firms adopting standard types of their own.

It will be as well at this stage to call attention to the great variety of merchant vessels that were under construction at this time. They totaled nearly five hundred, with an aggregate gross tonnage of over 1,800,000 tons. Among them were found fast and slow liners, intermediate passenger and cargo types, cargo boats built for special trades, fast cross-channel steamers, vessels built to carry special cargoes, "tramp" steamers, coasting vessels, and, in fact, all the varieties usually to be found in pre-war days. Even where the types were the same, individual vessels differed in size, speed, and arrangements. Many of them were built for special purposes, and practically all of them embodied ideas that were peculiar to particular owners and builders. While many of these specialties undoubtedly served their purpose it is perhaps questionable whether a number of them were absolutely necessary. At any rate, since the standardization of cargo ships has been introduced, it is generally conceded that much of it will continue to be practiced even after shipbuilding and shipping conditions have again become normal, the reason being that in many ways economy of time, material, and labor are obtained by its adoption.

It can at once be stated that the greatest variations, both from the point of view of degree and number, were to be found in vessels carrying passengers. The need, however, for refinements of type, comfortable passenger accommodation, record passages, etc., had ceased to exist at the time of the appointment of the Advisory Committee. On the other hand, the need for plain cargo carriers, and plenty of them, was greater than ever it had been before. It was therefore decided that the vessels already under construction which fulfilled to some extent these latter conditions should proceed, and that standard ships should be constructed with all possible speed.

Standardization

The principle of standardization having been accepted, it became necessary to design standard ships to meet the most urgent needs of the Shipping Controller. It was clearly desirable to limit the types as much as possible, but apart from the requirements of the Shipping Controller the employment of the available facilities in the shipbuilding yards to the greatest advantage had to be considered. For this reason several different lengths were used for the ships, in order to use the greatest number of slips to their best advantage. Needless to say, the practical difficulties were great. No two yards had built identical vessels; each builder had his own special knowledge, his own particular type or types of vessels. Again, practice differed in different districts. The practice in one district was looked upon with disfavor in another. Shipowners, moreover, were anxious, quite naturally, to have their fleets kept up, and preferred vessels of the types similar to those built for them in pre-war days.

It has been said that if builders had been allowed to proceed in their own way and to their own designs the output of ships would have been greater than it has been under standardization. Such a contention will not bear examination when all the facts are considered impartially. There has undoubtedly been delay in the production of standard ships in spite of all the arrangements made to expedite their construction, the chief element being shortage of steel. If each builder had been allowed to proceed with his own type or types of ships, this delay would have been greater, as in addition to not getting the amount of steel required, the multitudinous sections necessary would have caused great delay in rolling at the steel mills, whose output was much increased by the simplification of sections in the standard ships, referred to later. It is not sufficient to compare the rate of production of standard ships with the pre-war rate of production. The limited supply of steel and other adverse conditions must be taken into account.

The argument that delay was caused by asking builders to construct a standard ship differing only slightly from their own type may have some justification in regard to one ship, but not to repeat ships, and it must not be forgotten that never before had a proposition been put forward to build an unlimited number of ships of similar types throughout all the yards. It is interesting also to note that in one yard a standard ship was completed in a little over six months, although the yard had never built a similar ship before. A second similar ship was also completed in practically the same time. In another yard a ship was completed, coaled, and sailed 18 days after launching.

* Paper read at the spring meetings of the fifty-ninth session of the Institution of Naval Architects, London, March 20, 1918.
† Member of Council.

In spite, however, of all the difficulties and the diverse opinions held by responsible shipbuilders and engineers, the policy of building standard ships has been loyally accepted by them, and I think it may be claimed that as a war emergency measure the policy is being justified, and will in the future be justified to a much greater extent.

Advantages of Standardization

As the policy of building standard ships in bulk is a new one, it will not be without interest to put on record some of the advantages which are claimed for standardization of this kind. They may be summarized as follows:

(1) The detail design for the type can be entrusted to a builder who is conversant with that class of vessel and whose duty it becomes to make the necessary calculations, prepare the specification and all the constructional drawings, for the information of other builders instructed to build vessels of the same type. Small details can, however, still be arranged in accordance with the ordinary practice of the individual builder.

(2) The design being in the hands of one firm, all the steel scantlings after being settled in the ordinary manner can be carefully examined to reduce the number of steel sections in the ship as much as possible. This results in producing the fewest changes of rolls at the steel works and in the rolling of much larger parcels of material to the one pattern on account of the large number of ships that are to be built to this design.

As an example of this, in the standard ships now built the number of sections are reduced to 8 or 10 as against 30 to 40 used in pre-war days for the same type of ship.

(3) All the scrieve board work would be done by one yard giving full-size frame lines, beams, side keelsons, etc., copies of which can be supplied to the other firms concerned.

(4) Steel makers and builders can agree to divide the orders for material in accordance with the facilities of the steel works, and having regard to proper times of delivery, so that the material first required is the first in order of delivery.

(5) While there is not the same difficulty with steel plates as with sections, arrangements for the proper order of delivery can be made.

(6) With machinery the advantages of standardization are probably more generally agreed upon, and more detailed attention is given to this in Appendix II. It may, however, be remarked here that the elaboration and production of design for auxiliary machinery and detailed fittings can be divided among the various makers, and each can arrange to undertake the whole manufacture of the details of a particular requirement.

This does not by any means exhaust all the advantages of standardization, for after these preliminaries have been settled many benefits arise during the construction of the ships and engines. The standard ships, although not all of the same type, have many features in common. For instance, similar sets of engines may be fitted in ships of different types, so that apart from the large number built of each type there is a still larger number into each of which a given set of engines can be placed. In the case of any one vessel and set of machinery built in the same yard, it may so happen that either hull or machinery will be completed some time ahead of the other. In such cases the machinery originally intended for one ship can be transferred to another, no matter where it is being built. These rearrangements are of great assistance in preventing, on the one hand, congestion of the engine works, and on the other, delay to vessels through machinery being behindhand.

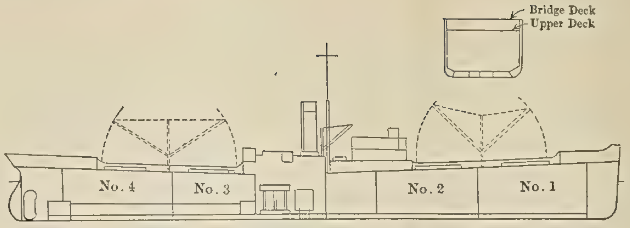


Fig. 1.—Type A. Single Decker with Poop, Bridge and Forecastle

Dimensions, 400 feet between perpendiculars by 52 feet beam molded by 31 feet depth molded; displacement, 11,375 tons; draft, 25 feet 1 inch; block coefficient, 0.762; deadweight, 8,175 tons; gross tonnage, 5,030; hull (steel) 2,225 tons; W. & O., 405 tons; engines, weight, 570 tons; light ship, 3,200 tons; engine, 27 inches by 44 inches by 73 inches by 48 inches stroke, single screw; boilers, three, 15 feet 6 inches diameter by 11 feet 6 inches.

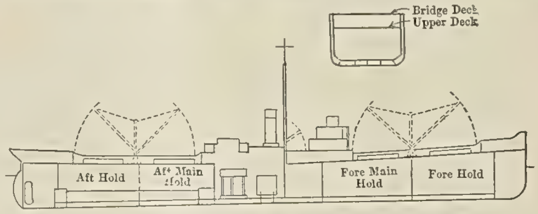


Fig. 2.—Type C. Single Decker with Poop, Bridge and Forecastle

Dimensions, 331 feet between perpendiculars by 46 feet 6 inches beam molded by 25 feet 6 inches depth molded; displacement, 7,200 tons; draft, 21 feet 8 inches; block coefficient, 0.760; deadweight, 5,050 tons; gross tonnage, 3,000; hull (steel) 1,390 tons; W. & O., 300 tons; engines, weight, 460 tons; light ship, 2,150 tons; engines, 25 inches by 41 inches by 68 inches by 45 inches stroke, single screw; boilers, three, 14 feet diameter by 11 feet 6 inches.

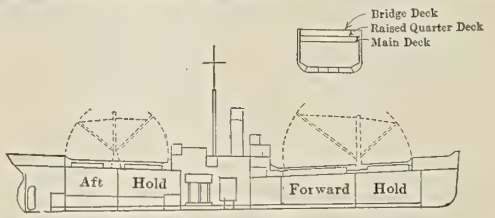


Fig. 3.—Type D. Raised Quarter Deck with Poop, Bridge and Forecastle

Dimensions, 285 feet 6 inches between perpendiculars by 41 feet 9 inches beam molded by 21 feet 2½ inches depth molded; displacement, 4,750 tons; draft, 19 feet; block coefficient, 0.732; deadweight, 2,980 tons; gross tonnage, 2,300; hull (steel) 1,110 tons; W. & O., 240 tons; engines, weight, 420 tons; light ship, 1,770 tons; engines, 25 inches by 41 inches by 68 inches by 45 inches stroke, single screw; boilers, two, 16 feet 6 inches diameter by 11 feet 9 inches.

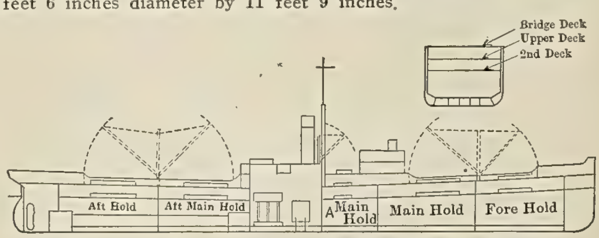


Fig. 4.—Type E. Two Decker with Poop, Bridge and Forecastle

Dimensions, 376 feet between perpendiculars by 51 feet 6 inches beam molded by 29 feet depth molded; displacement, 9,910 tons; draft, 23 feet 9 inches; block coefficient, 0.749; deadweight, 7,020 tons; gross tonnage, 4,400; hull (steel) 1,920 tons; W. & O., 400 tons; engines, weight, 570 tons; light ship, 2,890 tons; engines, 27 inches by 44 inches by 73 inches by 48 inches stroke, single screw; boilers, three, 15 feet 6 inches diameter by 11 feet 6 inches.

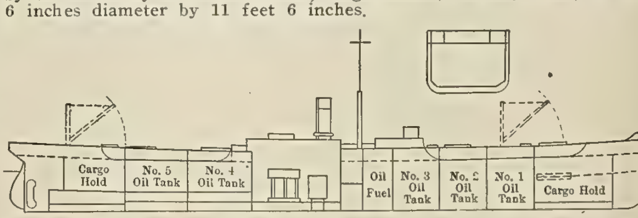


Fig. 5.—Type Z. Single Decker with Poop, Bridge and Forecastle

Dimensions, 400 feet between perpendiculars by 52 feet beam molded by 31 feet depth molded; displacement, 11,400 tons; draft, 25 feet 1 inch; block coefficient, 0.762; deadweight, 8,000 tons; gross tonnage, 5,800; engines, weight, 570 tons; light ship, 3,400 tons; engines, 27 inches by 44 inches by 73 inches by 48 inches stroke, single screw; boilers, three, 15 feet 6 inches diameter by 11 feet 6 inches.

The auxiliaries and fittings, including forgings and castings, being alike in vessels of each type, can be ordered in large numbers from the same maker and used in any ship or ships which may be ready to receive them.

Standard Ships

Outline profiles and midship sections are given of some of the standard ships in Figs. 1 to 5, together with their principal dimensions and particulars. The general arrangement of the machinery as fitted is shown in Fig. 6.

The first two designs made were the "A" and "B" types. Both these vessels are of the same dimensions, but the first is of the single-deck, and the second of the two-deck type; their length is 400 feet, and deadweights 8,200 and 8,100 tons, respectively.

These types were followed by the "C" type, length 331 feet, and deadweight 5,050 tons, and the "D" type, length 285 feet, 2,980 tons deadweight.

The "C" and "D" types were laid down on the shorter berths as they became available, and later the "E" type was added so that the best use might be made of berths exceeding the "C" vessels' length, but under the "A" and "B" length; the "E" type is 376 feet in length and 7,020 tons deadweight.

For these five types of vessels two standard types of engines only were required. The "A," "B," and "E" vessels are all fitted with the standard "A" engines. The "C" and "D" vessels again have a type of engine common to both, although in the case of the "C" type additional boiler power is provided.

To meet the urgent need for more oil carriers an important alteration was made later in the construction of a number of the "A" and "B" type vessels, through which, if the necessity arose, they could be completed as oilers.

In addition heavy oil carriers of 8,000 tons capacity known as the "Z" type are building. The overall dimensions of the "Z" vessels are the same as the "A" and "B"; the same standard type of engines are used as in the "A," "B," and "E" vessels.

All the types mentioned, except the "Z" oiler, were decided upon, the designs prepared, and details arranged while the Merchant Shipbuilding Advisory Committee was still meeting at the Ministry of Shipping, and other types were projected.

In designing the standard ships a point kept in view was the necessity for producing as quickly as possible plain cargo boats of the maximum carrying capacities with the least expenditure of material and labor, and of sizes most suitable to the majority of building berths, and shipping conditions, etc. I feel that it is necessary to emphasize this statement because obviously the Government standard ships were designed to meet urgent war conditions. While they might have a bearing on future standardization, the question has not been dealt with from a peace standpoint.

The detailed design of each type in the first place was entrusted to a builder conversant with the class of vessel required and whose duty it was to carry out the work already mentioned. The engines were dealt with in a somewhat similar manner except that one Scotch and one English engineer used to the class of work collaborated on the one design and its details—these and the designs of the ship afterwards meeting that the full assent of the committee. It was arranged with the Classification Societies should concur in the various scantlings, and undertake, on behalf of the Ministry of Shipping, the entire supervision of the vessels during construction. Two surveyors of Lloyd's Register who had been associated with the Ministry of Munitions in the production of steel were assigned the duty of allocating the orders for steel material to the steel works and of arranging for its distribution to the builders in conjunction with the Government officials as required.

To facilitate the loading and discharging of cargoes large hatchways were arranged with an ample provision of derricks and winches. In the same connection the pillars were specially arranged as mentioned in Appendix I. Further points of detail are discussed in Appendix I for the hull and in Appendix II for the machinery.

General Considerations

As experience was gained with vessels already at sea which had received damage by mine or torpedo, it was only to be expected that modifications would be suggested. For this reason certain alterations were effected in the early standard ships after the plans were prepared. These were principally made on the advice of the anti-submarine authorities; but one other particular alteration is worthy of mention, in that greater safety and comfort is given to the crew by quartering them in the poop rather than in the forecastle, as was the usual practice before the war.

It will be remembered that the Council of the Institution formed a committee last year to consider the question of the effect of mine and torpedo explosions on the structure of merchant ships. The majority of the findings of this committee, it will interest members to know, were embodied in the standard ships.

Certain precautions were taken to render the visibility of the standard ships as small as possible. Some of these can be mentioned, while others had better be left unnoticed. The derricks and derrick posts were made to hinge down, and there is only one mast for carrying the wireless aerials. This latter is partly telescopic and can be let down to the same level as the top of the funnel. The funnel is also made lower than usual. Ordinary deck-houses were fitted, and these in conjunction with other outstanding features of the ship can be masked by those on board when desired by the use of arrangements provided.

The speed and horsepower of the standard vessels have purposely been omitted from this paper. There must be many to whom these particulars are familiar. Perhaps there are still some who think that the vessels should have been given greater speeds, although the speeds are somewhat higher than is usual for this type of ship. The direct answer to this is that the actual speeds were concurred in by the Admiralty, who were in a position to know the requirements in that direction better than anyone else. This was the guiding factor of the committee; but it cannot be overlooked that increase of speed in any ship can only be obtained at great cost, and this is particularly the case in cargo ships of full form. Apart from this, at the time the standard ships were designed, consideration was given to the successful commercial use of these vessels after the war. Nevertheless, the great loss in cargo-carrying that would be entailed by fining up the lines, increasing the power of the engines, and the fuel that the vessel would have to carry, etc., must be considered when the question of speed is being viewed from all standpoints.

The bulkheads of the standard ships are discussed in Appendix I, but it may not be out of place here to refer to what are termed "unsinkable" ships. The word "unsinkable" must, of course, be used in a relative sense, because any ship can be sunk provided she receives a sufficient amount of damage. Advocates of unsinkable ships themselves usually specify that the word only applies to some definite amount of damage. Any responsible naval

architect can design such an unsinkable ship, and actually many such designs were submitted to the advisory committee. There is one objection, however, which is common to all such types of vessels; in every case they require the expenditure of more steel per ton of deadweight carried. At the time the advisory committee was formed, as has already been indicated, steel was extremely scarce. Apart from this, all provisions for safety, if of an appreciable value, must complicate the cargo arrangements. Some curtail the amount of cargo carried, and all render it more difficult to handle the cargo. This, apart from increased steel required in construction and lengthened time of building, further limits the carrying capacity of the ship by increasing her time for loading and unloading.

Conclusion

In May, 1917, the Department of the Controller of the Navy was formed and the work hitherto done by the Ministry of Shipping in connection with merchant shipbuilding was transferred to the new department. The merchant shipbuilding advisory committee was also transferred, but shortly after this, for reasons which need not be stated here, the committee resigned and the Controller of the Navy immediately formed a Shipbuilding Council to assist him in regard to all matters respecting shipbuilding, both merchant and warship building and repairing. The members of the old advisory committee became members of this council.

Further types of standard ships have been evolved recently, but I do not propose to include them in this contribution. Enough has been said to illustrate the general principles involved.

To introduce any general system of standardization of ships would have been difficult in normal times; it is only to be expected that it has proved to be so even in the midst of the greatest war in history. On the other hand, the need having arisen so acutely, called for the attempt to be made. That criticism has arisen as to the Shipping Controller's policy, and the advisory committee's action, was only to be expected when one considers the eminent ship designers and shipowners who have special ideas and interests in the design of some ships already built, and the many ideas that have at one time or the other been proposed. That good results have, however, been attained will, I have no doubt, be generally conceded, and the appointment of a committee to consider the general standardization of marine engines is a sign that we may expect standardization to play a definite part in the future. In post-war work we shall have to consider everything making for cheapness and rapidity of production, and standardization will not be the least among such considerations.

APPENDIX I

Hull Details

In all the vessels the longitudinal and transverse scantlings have been designed generally to comply with the standard of strength recommended by the load line committee.

With a view to obtaining simplicity of construction, special consideration was given to the arrangement of the details of the structure, and it was decided to omit the ceiling on the tank top and the stringer on the ship's side, to fit only one keelson on each side in the double bottom, and to have large single angles at the upper and lower edges of the center girder, suitable structural compensation or arrangements of equivalent strength being fitted in each case. The open bottom method of construction with solid floors on every third frame was adopted in the holds and boiler space, except in types "C" and "D," where, on account of the probability of these vessels being engaged in carrying ore and coal cargoes, solid floors are fitted on every frame throughout.

To reduce labor and avoid the necessity of bending the main frame, brackets of extra depth are fitted on the tank margin and no tumble home was given to the frames at the top sides. Only a center row of pillars, reeled for shifting boards, was fitted (except for hatch side pillars in types "B" and "E"), and advantage was taken in several instances of the relative position of the hatchways and watertight bulkheads to support the deck by large brackets attached to the bulkheads, the holds being thus as free as possible from obstructions of any kind. To compensate for the absence of pillars at the sides of the hatchways, an arrangement of reinforced hatch-end-beams and side coamings was adopted, the latter being also incorporated in the longitudinal strength of the ship in the way of the hatchways nearest amidships. In types "B" and "E," on account of the excessive depth required in the reinforced hatchways, side coamings and end beams at the second deck, when center pillars only were fitted, it was decided to fit a pillar under each hatchway side coaming at the middle of the length of the hatch.

The officers and engineers, in accordance with the most recent practice, are berthed together in a large house at the fore end of the bridge deck.

Approximate flooding calculations were made for all types of the standard ships.

In vessels "A," "B" and "E," with the main bulkheads in the positions arranged by the builders, it was found that, by making the cross-bunker bulkhead watertight, the vessels would approximately comply with the "two compartment" standard in way of the machinery space and cross bunker, and the "one-compartment" standard elsewhere. The position of the cross-bunker bulkhead was arranged in order to fulfil the above-mentioned conditions.

In vessel "C," in addition to the bunker bulkhead, an additional bulkhead was fitted in the after hold, in order to comply with the same condition.

Among the detailed requirements carried out in these ships which meet the findings of the committee appointed by this Institution to inquire into the effects of mine and torpedo explosions might be mentioned the following: No watertight door is fitted between the engine room and the shaft tunnel, an access trunk being provided from the upper deck to the forward end of the tunnel. In addition, where watertight doors are fitted, they can be worked from an upper-deck position. Each suction pipe, where it enters the compartment from which it drains, is provided with a screw-down non-return valve worked from the bulkhead deck.

APPENDIX II

Engine Details

The details of the engine design are arranged so that the machinery is rather overdriven for war emergency measures; this policy was followed so that after the war the ships become fairly reasonable commercial propositions. For example, the "A" engine would in peace time probably run at about 80 percent of the power obtained from it at present.

As with the hull, all the designs, when settled as previously mentioned, with the exception of the auxiliary machines, were prepared by one firm and issued to the various machinery contractors complete, together with full detail specifications of all the raw material orders and the finished items which it was arranged to obtain from subcontractors. The drawings and information issued contained quite an unusual amount of detail, so that firms not

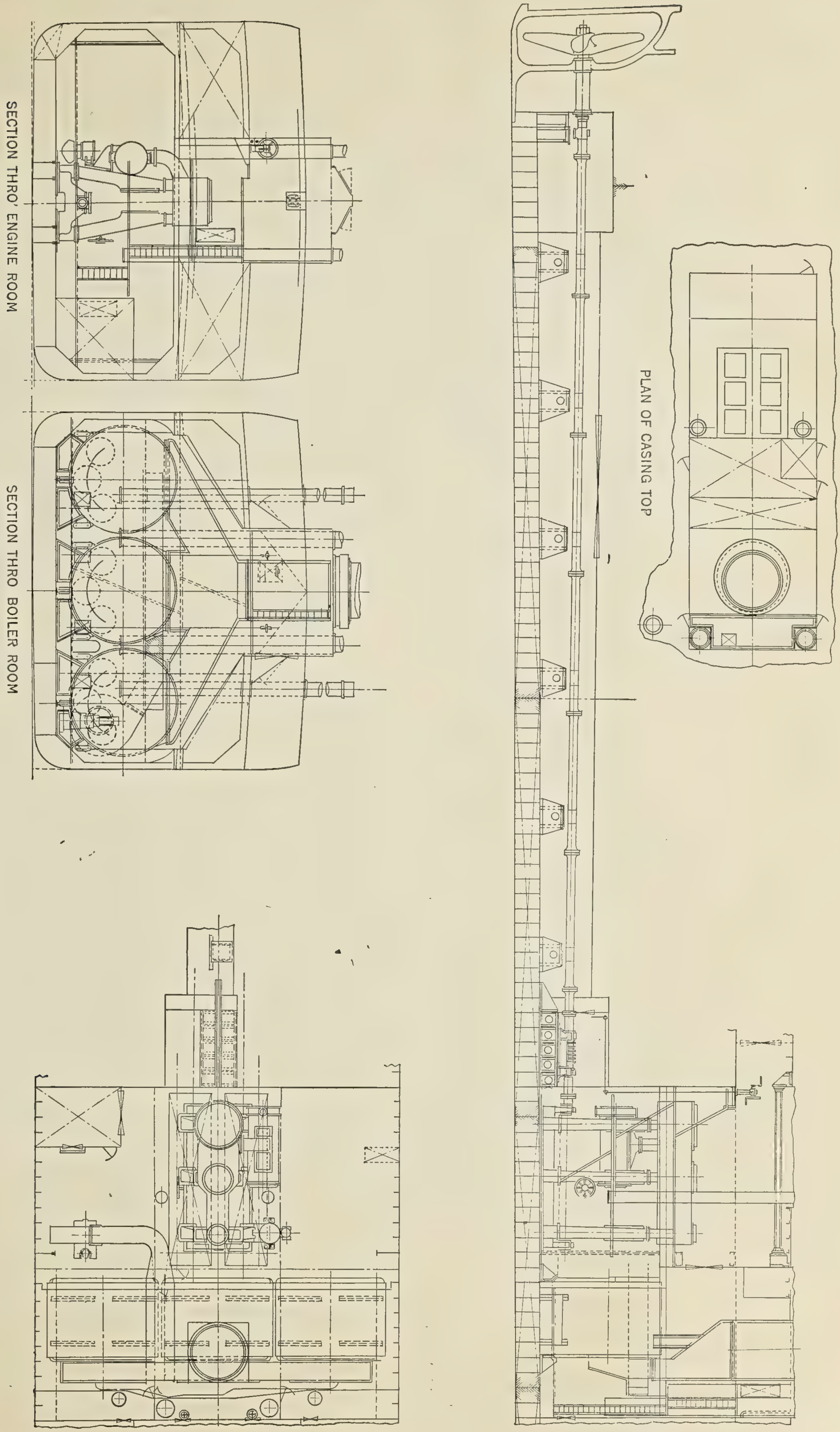


Fig. 6.—General Arrangement of Machinery for Standard British Cargo Ships

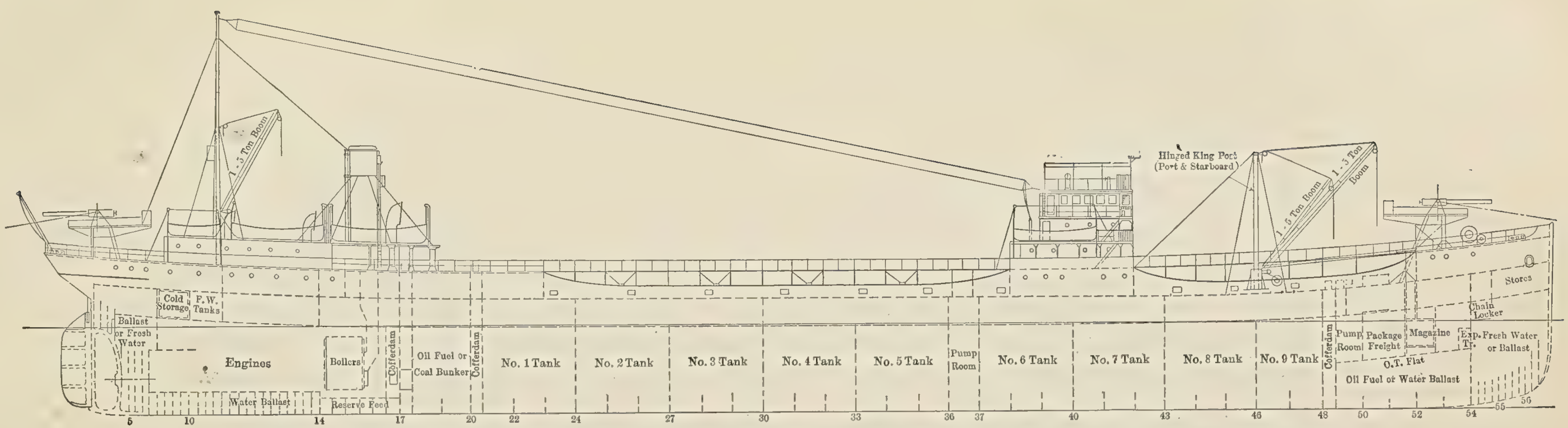


Fig. 1.—Usual Type of Standard 10,000-Ton Oil Tank Steamship, Designed and Built by the Sun Shipbuilding Company, Chester, Pa.

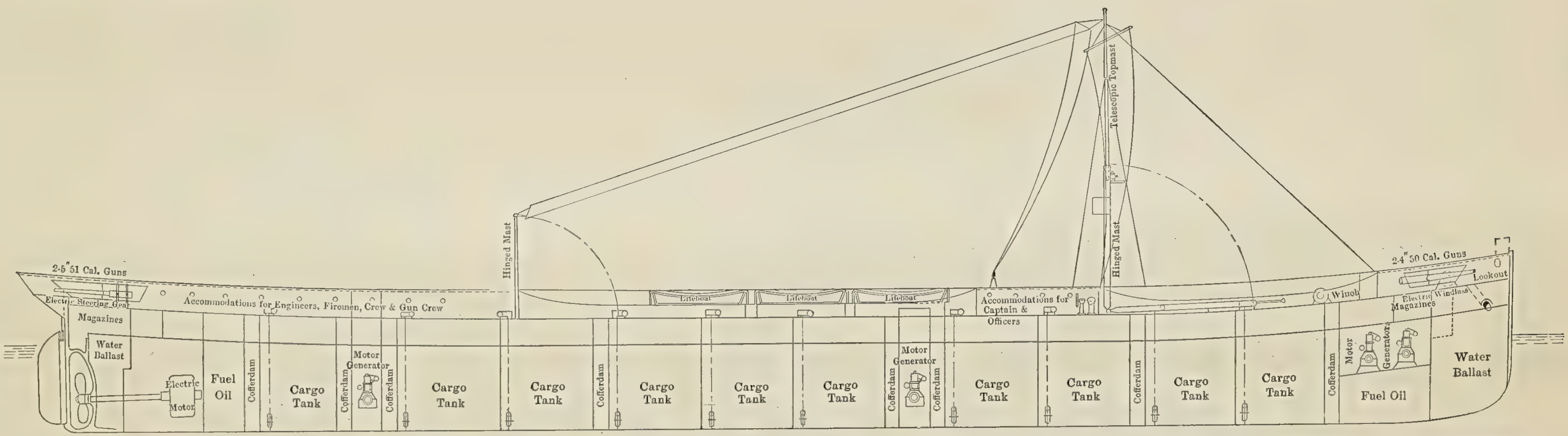


Fig. 2.—Modified Design of 10,000-Ton Oil Tanker Proposed by the Sun Shipbuilding Company. Tanks Are in Pairs Separated by Cofferdams with Independent Bulkheads. Large Machinery Space Is Eliminated by Adoption of Electric Drive, the Current Being Supplied by Six 700-Horsepower Oil Engine Driven Generating Sets Distributed in Small Compartments Throughout the Vessel. Low Visibility Secured by Elimination of Smokestack, Deck Houses and Rigging

familiar with such work would have no difficulty in carrying it out.

The main engine design does not present any new features. There are, however, some outstanding details. The front columns which carry the astern piston rod guides have been utilized as engine oil tanks. The moving parts of the engine are of the simplest type, and every attention has been paid to facility for overhaul.

The line shafting is all in interchangeable lengths.

The reversing gear is of the all-round type, and a turning engine and gear is fitted at the after coupling.

Ease of machining and assembling has been provided for in the arrangement and in the details, the piston type of valve for the medium pressure cylinder, for example, being adopted chiefly on that account. The centrifugal circulating pump is mounted with its engine on the main engine bedplate, so that it can be fitted complete with its pipes and connections in the erecting shop.

Reference has been made in the paper to the advantages derivable from interchangeability, and examples of it have actually occurred. One firm, on discovering a defective sole plate casting, had it replaced at once by a similar casting from another firm who did not require it at the time; this avoided a delay of several weeks in the erection of the engines. In another case a replaced main steam pipe branch piece was immediately dispatched to a vessel ready for her trial trip, the original one having shown leakage on the first steaming of the engine. Sub-contractors in particular were benefited by the multiple work, as they were enabled to proceed with a large number of each article instead of finding differences in small points of design, as invariably occurs when the designs are prepared by independent firms or individuals.

The principle of repetition in designs was embodied everywhere. Small castings were ordered in multiple.

Apart from the advantage to the sub-contractors in carrying out repeat-work, small items in the engine room which could be manufactured to better advantage by specialists rather than by large firms were ordered in large numbers for all the firms involved. This would not have been possible had they been different for each vessel. The orders for items such as auxiliary machinery, valves, valve boxes, branch pieces, cast and wrought iron pipes, and so on, were issued in multiple from a single source by firms specializing in this work. For example, the main steam pipes were finished complete by tube makers, the drawings having been so designed that the unavoidable inaccuracies in fitting boilers and engines in place could be taken up at the joints, thus overcoming the delay which otherwise invariably occurs when pipes have to be made to fit after everything else is in position.

The auxiliary machinery was arranged so as to give the least work in completing the vessel after it was launched, the various connecting pipes being of the simplest form while providing all the usual conveniences for working.

The feed filter and feed heater were embodied in a compact form in the engine hot well, the feed filter being easy of access. The winches exhaust to a winch condenser in the engine room, the size of which is ample to deal adequately with the winches when they are being used for a rapid discharge of cargo. The general service donkey and harbor feed donkey are duplicates, and are capable of feeding the boilers in port or at sea.

The use of copper piping was avoided as much as possible, and wrought iron was largely used in consequence, except for very small pipes. The result is that the weight of copper piping is less than one-sixth the usual amount in this class of vessel.

The boilers are fitted with Howden's forced draft.

Modified Design of Standard Tanker

IN common with other ship owners, the Sun Oil Company, of Philadelphia, has not been able to escape entirely the ravages of the German submarine warfare. Several of its vessels have been sunk by German torpedoes and their experience has led the Sun Shipbuilding Company, Chester, Pa., to work out the design of an oil tanker in which the risk of loss from torpedo or mine attack can be materially lessened.

In the past, tankers have been sunk either by being hit in the engine room—in which case the vessel sinks because there is not sufficient reserve buoyancy to keep it afloat—or the vessel is struck forward of the engine room and the bulkheads forward of the machinery space are blown out, so that the vessel catches fire or the engine room is flooded, or the vessel is struck forward, bringing the vessel down by the head to such an extent that water gets in the 'tween deck space and, gradually working its way aft, finally destroys the reserve buoyancy. These are results which have been brought about with vessels designed with the usual standard arrangement, as shown in Fig. 1, on the opposite page.

The modified design, shown in Fig. 2, provides protection against all three of the contingencies enumerated above. The main oil tanks are arranged in pairs, but a cofferdam is interposed between each pair of tanks. The bulkheads forming these cofferdams are absolutely independent of each other. With this arrangement the explosion of a torpedo in any one of the tanks, it is believed, will be limited to the space between the cofferdams forward and aft of the pair of tanks. All of the bulkheads run up to the upper deck and the explosion of a torpedo on one side of the cofferdam would affect only one of the cofferdam bulkheads, as the two are entirely separate, the space between giving a vent for the explosive pressure in the tank.

In the modified design, the large machinery space aft is done away with entirely, so there is no large compartment in the ship, the flooding of which would mean its destruction. In place of the usual arrangement of propelling machinery, the vessel will be driven by an electric motor located in a small compartment aft and supplied with current from a number of oil engine-driven generators distributed in various parts of the vessel. In the design shown there are three separate generator rooms, each being protected by cofferdams on either side. In all, there are six 700-horsepower motor-driven generators, giving over 4,000 horsepower, which is sufficient to give the vessel a speed of 12 knots, as against 10½ knots in a similar steam tanker. This method of propulsion, at the same time, will save 1,000 tons in fuel on a transatlantic voyage, which means that the vessel can deliver 1,000 tons more cargo on the other side.

The trim of a modified vessel, in case she is struck by a torpedo, is taken care of by large rotary pumps installed in each side of each tank and driven by electric motors from the upper deck. This is a system which has already proved its usefulness in practice on several tank steamers now in use, the most notable installation of the kind being on the Union Oil Company's steamship *La Brea.*

The average steam vessel, when struck with a torpedo, is immediately crippled. This modified vessel, however, it is claimed, can still run at a fairly good speed and can maneuver so that it continues to be dangerous for submarines until struck in the motor room at the extreme after end of the ship. At this point, however, it is believed that the water, due to the action of the propeller, is so turbulent that it would be practically impossible for the torpedo to strike the vessel, as it would be diverted

and thrown away from the ship. Careful investigation has failed to discover a single instance where a ship of this model has been so struck or the torpedo drawn into the propeller.

Besides the protective features against torpedoes, however, this modified design has the further great advantage of minimum visibility. The hull presents an absolutely straight skyline from stem to stern. There are no deck houses, funnels or other erections above the deck level except a single mast for the wireless, which, however, is hinged and can be lowered below the deck line. The hull is of the three-island type, with forecastle, bridge and poop. These decks are connected by a fore-and-aft bridge, to the lower side of which are hung light hinged plates to fill in the open space between the fore-and-aft bridge and the top of the bulwarks, filling out the profile so that the skyline is absolutely straight, which, with the absence of funnels and smoke, reduces the visibility of the vessel to an absolute minimum.

The standard design of tanker can be utilized for a vessel of this type, and vessels of the modified design can be built practically as rapidly as the standard design of tank steamers. Estimates show that the cost of the modified design is less, while the operating expenses will be reduced in the same proportion as in the case of an ordinary motorship.

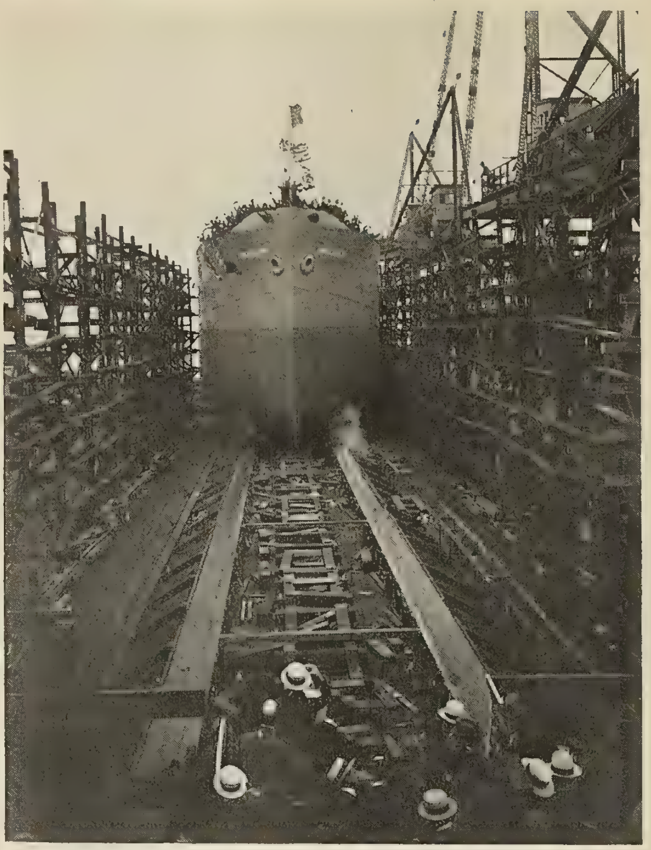
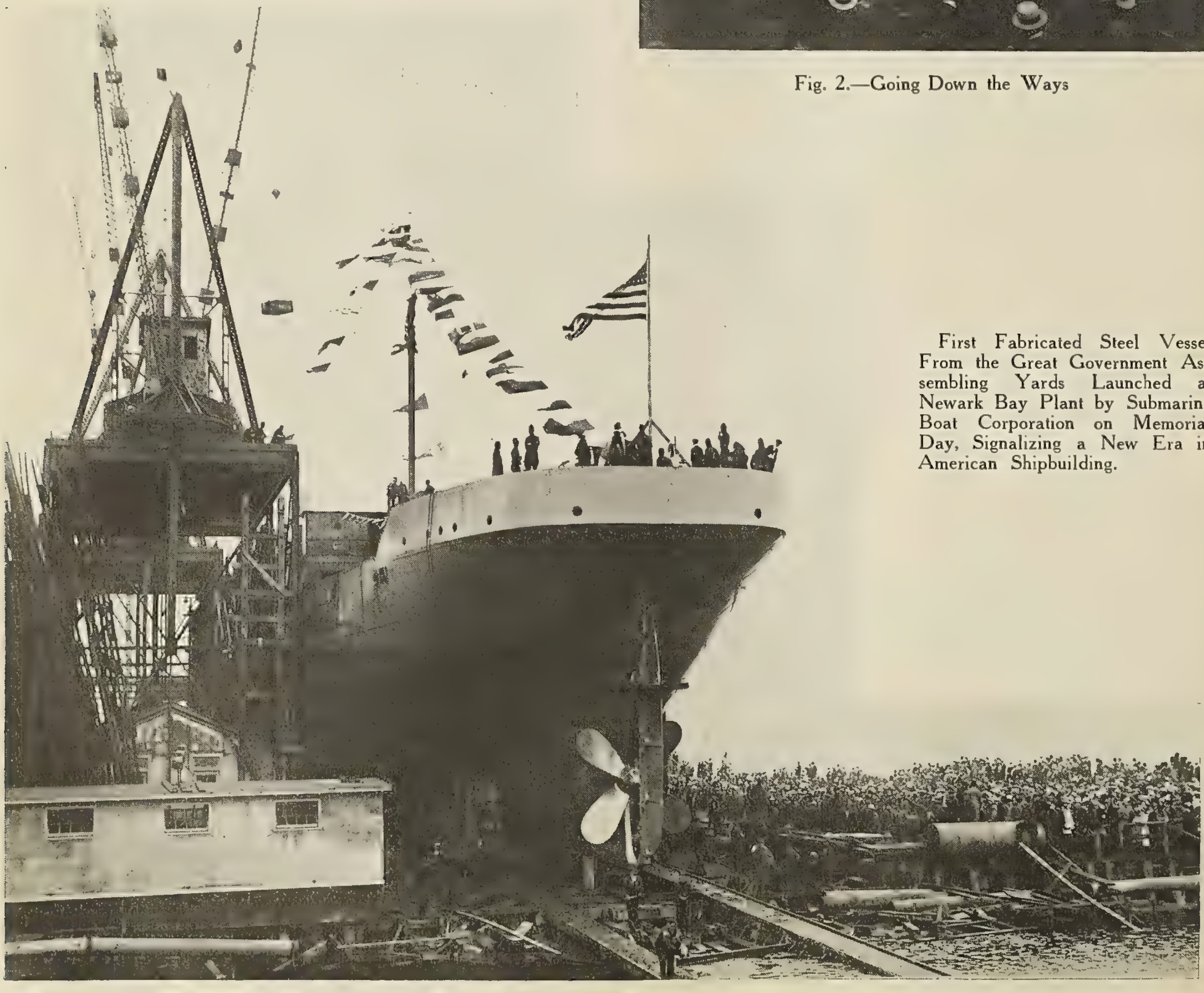


Fig. 2.—Going Down the Ways



First Fabricated Steel Vessel From the Great Government Assembling Yards Launched at Newark Bay Plant by Submarine Boat Corporation on Memorial Day, Signalizing a New Era in American Shipbuilding.

Fig. 1.—S. S. *Agawam* Ready for Launching

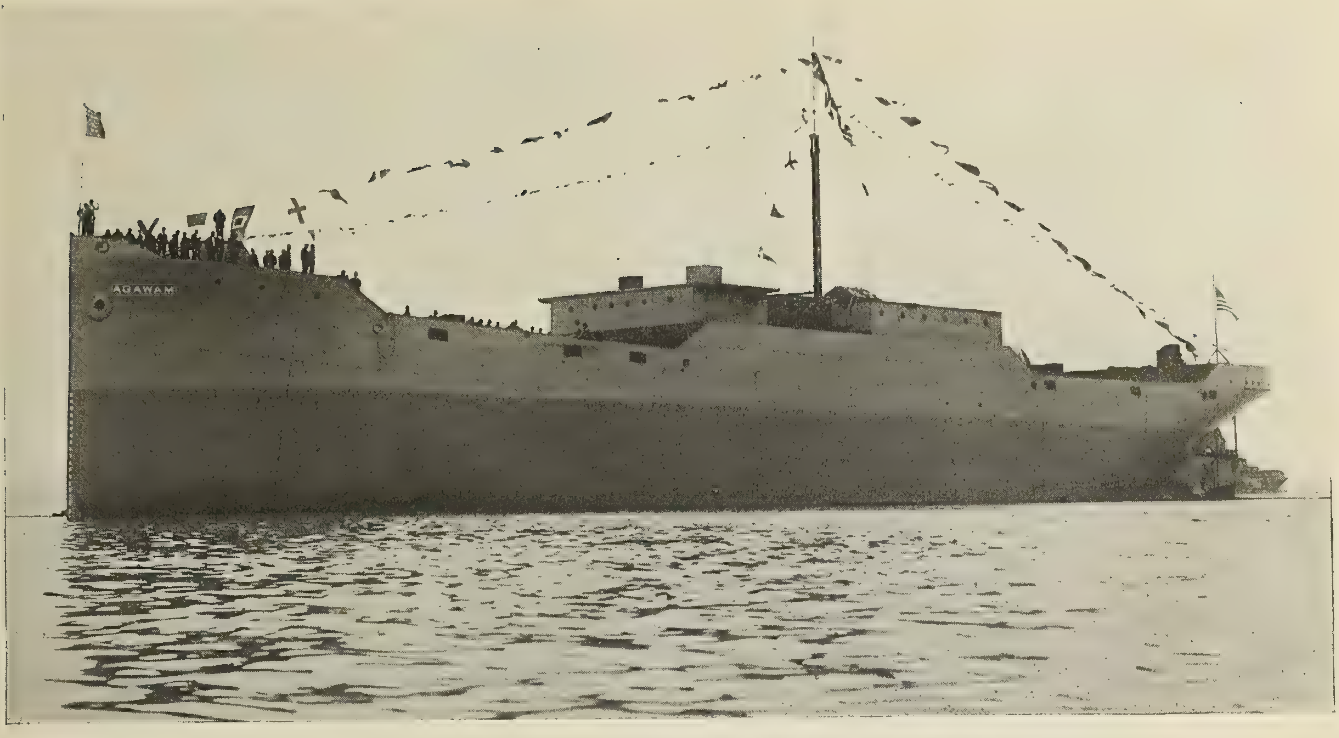


Fig. 3.—Side View of the *Agawam* Immediately After Launching

This design, which it is believed will remove at least 90 percent of the submarine risk, has been offered to the Shipping Board by the Sun Shipbuilding Company, so that any shipyard in the country equipped for building tank steamers can make use of it without restrictions of any kind.

Launching the First Government Fabricated Steel Ship

The first vessel to go into the water from the big government yards for assembling fabricated steel ships was the *Agawam*, which was launched by the Submarine Boat Corporation, at the Newark Bay Plant, on May 30. Nearly ten thousand persons witnessed the ceremony, among them being Charles M. Schwab, Director General of the Emergency Fleet Corporation, Thomas Edison, chairman of the Naval Consulting Board and many of the leading shipbuilders on the Atlantic Coast and Great Lakes.

The vessel was christened by Miss Mary E. Ward, Mr. Schwab's niece. Following the launching, addresses were made by Director General Schwab and officials of the company, emphasizing the significance of the event and the rapid development of the government shipbuilding programme.

Fig. 4.—View of the *Agawam* Showing Slight Flare at the Bow and Extent of Parallel Middle Body

The outstanding feature of this launching is the fact that the *S. S. Agawam* is the first standardized steel cargo vessel built from structural steel shapes and plates to be launched for service of the Emergency Fleet Corporation. All other vessels of both steel and wooden construction launched at the various yards on the Atlantic coast during the last few months were ships that had been privately contracted for and commandeered during construction by the United States Shipping Board.

The various steel parts of the vessel's hull and superstructure were fabricated as completely as practicable in structural steel shops throughout the country and then assembled at the Newark Bay Shipyard into a complete vessel. This is a decided innovation in the

shipbuilding industry and gives promise of great success in economy and speed of production heretofore not thought possible.

Approximately 27 steel mills, 56 fabricating plants and 200 foundries, machine, pipe, joinery, and equipment shops, are engaged in the production of the parts to make up the finished steamship.

The *Agawam* will have a displacement of approximately 7,800 tons when loaded to the Plimsoll mark, and a deadweight carrying capacity of about 5,500 tons. The length of the vessel is 343 feet on deck, the molded breadth being 46 feet and the molded depth of hull, 28 feet and 6 inches. The maintained speed of the vessel at sea fully loaded, will be at least 10½ knots on a mean draft of approximately 23 feet.

Propelling Machinery

The main machinery consists of a Westinghouse steam turbine operating at 3,600 revolutions per minute, driving the single screw propeller at 90 revolutions per minute through a Westinghouse balanced floating type reduction gear. Steam supply to the turbine will be furnished by two Babcock & Wilcox marine-type watertube boilers, which were installed in the ship before launching. The auxiliary machinery of the vessel will be most complete, including duplicate electric light plants, refrigerating plant, pumping machinery for numerous systems, forced-draft blower, evaporator, heaters, cargo handling machinery, windlass, capstan, steering engine, auxiliary condenser, etc. Fuel oil will be used in the boilers for generation of steam, this fuel being carried in compartments of the double bottom of the ship in sufficient quantity to more than cover the round trip to Europe.

Ample and comfortable quarters are provided for officers and crew.

As every vessel to be built at this shipyard is of the same size and type, the time required for construction and completion will be much less than has heretofore been required for such work, and from the 28 construction-ways in this yard it will be possible to launch hulls on an average of at least two and possibly three per week, insuring delivery from the fitting-out docks, ready for sea, at the same rate of completely finished ocean-going steamships.

Mrs. Woodrow Wilson has most appropriately selected names of Indian origin for the vessels of the Emergency Fleet Corporation and has made a particularly happy choice in the name of *Agawam*—a literal translation of which is "Great Salt Meadows of the Atlantic Coast."

Structural Steel Used Exclusively

The fabrication of steel cargo vessels using exclusively structural steel shapes and plates which have hitherto been employed only in the erection of bridges, office buildings, theatres, etc., is the original idea of Mr. Henry R. Sutphen, vice-president of the Submarine Boat Corporation and was worked out to a practical conclusion in conjunction with bridge builders and naval architects. Mr. Sutphen had suggested and supervised the building of 550 submarine chasers for the British Government in 1915 and 1916, which were delivered in the incredibly short time of 550 days from the signing of the contracts. This tremendous undertaking proved the efficacy of standardization in shipbuilding and was the "tryout" for the bigger job that is at present being undertaken.

Making experiments at sea may result in having to limp into port. Make experiments as close to a repair shop as possible.

Steamboat-Inspection Rules Amended

The steamboat-Inspection Service has issued a circular letter dated May 27, 1918, addressed to inspectors of the service, steamboat companies, and others concerned, containing amendments of the General Rules and Regulations of the Board of Supervising Inspectors and approval of vessel equipment adopted by the executive committee of the board, at a meeting held from May 11 to 22, inclusive, 1918, as follows:

Carrying of Kerosene (Paraffin) and Lubricating Oils on Steam Vessels

The following resolution prescribing the method of carrying kerosene (paraffin) or other illuminating oils and lubricating oils on steam vessels, in pursuance of a recent act of Congress, was adopted:

Resolved, That in order to carry into effect the amendment to section 4472, R. S., as provided in bill S. 1546, Sixty-fifth Congress, "An act to permit the use of certain refined products of petroleum as stores on steam vessels carrying passengers," approved March 29, 1918, the following regulations are hereby prescribed for the storage of kerosene (paraffin) and lubricating oils, viz.:

Lubricating oils may be stored as heretofore in secure tanks, casks, or cans in the engine-room compartments or storeroom, or in metal-lined lamp lockers or oil rooms. Kerosene (paraffin) or other illuminating oils meeting the requirements of the law must be stored in metallic tanks or cans, and carried in the oil rooms or lamp lockers constructed in accordance with the general rules and regulations.

Stamping of Heads and Butt Straps of Boilers

The following resolution relating to method of stamping of heads and butt straps of boilers by inspectors was adopted:

Resolved, That the paragraph under the heading, "Test of plates for butt straps or boiler heads," as contained in the Eighth Supplement to General Rules and Regulations issued November 15, 1917, be amended by inserting after the word "stamp" in the last line of the said paragraph the words, "in one place where it is most likely to be left legible after working into the boiler," so that the paragraph as amended shall read:

TEST OF PLATES FOR BUTT STRAPS OR BOILER HEADS

Resolved, That, until further ordered, inspectors testing iron or steel plate at the mills where same is manufactured shall allow the mills to shear any plate into butt straps or heads before the coupon from the plate is tested, and they shall accept the statement of the manufacturer that the coupon presented to the inspectors for testing was taken from the plate from which the butt straps or heads were cut, and if the coupon meets all the requirements of Rule I, Rules and Regulations of the Steamboat-Inspection Service, the inspector shall stamp in one place where it is most likely to be left legible after working into the boiler all heads and butt straps cut from the plate.

Vessel Equipments Approved

The following-described vessel equipments were approved:

Kapok life-preserver jacket, presented by the G. H. Masten Company, New York, N. Y.

Sanitary Java kapok life-preserver vest, presented by the Everfloat Life Preserver Company, New York, N. Y.

Coston improved life belt (combination cork and kapok), presented by the Coston Supply Company, New York, N. Y.

Cambridge life float, presented by The T. J. Flynn Metal Works (Inc.), Cambridge, Mass.

Sweeney life float, presented by the Herreshoff Manufacturing Company, Bristol, R. I.

Fire gun fire extinguisher No. 1, 1 quart size, carbon tetrachloride, manufactured by the Fire Gun Manufacturing Company (Inc.), New York, N. Y.

The above action of the executive committee received

the approval of the Secretary of Commerce on May 25, 1918, under the provisions of sections 4405 and 4491, Revised Statutes.

The Future of the German Merchant Marine*

WITH no branch of Germany's economic life has the world war played such havoc as with German over-sea shipping. A good two-thirds of the collective German trade fleet has, up to the present, through seizure or capture, fallen into the possession of the enemy or been sunk, or else appears to be greatly imperilled.

To this must be added the frequently overlooked fact that German over-sea shipping firms have, since the beginning of the war, despite the absence of any income worth mentioning, been obliged to spend, month in and month out, enormous sums for keeping their ships lying in neutral harbors in good condition, for harborage, and for the hire and support of the seamen on these ships—expenditures which have, of course, gradually become less with the entrance of the majority of the States originally neutral into the coalition against us, yet which still to-day require considerable quotas. There must, furthermore, be added the taxes at home, the cost of keeping in condition the ships lying here, the usual business expenses, the support of those employees who have joined the colors and of their dependents, and much besides.

Tthe handsome profits which some of the large German shipping firms have gathered since 1916 through the transportation of iron ore and coal in the Baltic Sea can, in the face of these expenditures, hardly be considered as more than a drop upon a hot stone.

Serious After-the-War Competition

If the predicament of the German over-sea shipping firms appears on the very face of matters to be an extremely difficult one, it appears still more perilous when it is compared with the foreign competition that it must meet on the world's seas after the end of the war, for the shipping companies of the neutral and enemy countries have earned altogether fantastic sums during the years of the war. They have thereby not only been in a position to declare dividends of unprecedented size, but have in addition to this also transferred vast sums to reserve and emergency funds, whereby their ability to compete against the weakened German shippers has increased to such an extent that one cannot but face the coming war of competition with concern.

There has, furthermore, arisen in the neutral countries a lot of new and, at the same time, exceptionally well capitalized shipping enterprises that will likewise have a weighty word to say in the shipping rivalries after the war.

"Outlook by No Means Rosy"

A survey of the situation will lead inevitably to the admission that the outlook for the German over-sea shipping firms after the war is by no means rosy. The German Government's gratifying measures of assistance in favor of the shipping trade do not alter the situation in the least. For even if the shipping firms are granted considerable sums for the construction of ships to replace the ones lost, in accordance with the provision for the reconstruction of the German merchant marine, yet, on the other hand, the sums to be paid out according to the law are so adjusted that even in the most favorable cases the shipping firms have at least to bear a portion of the cost of reconstruction, equivalent to the value of the ship in peace times. The indebtedness of the shipping firms will therefore, in spite of the law, be subjected to a still greater increase before they obtain possession of sufficient tonnage to enable them to resume the struggle for their former fields of activities. This fact alone reveals plainly enough that the law amounts much less to a patronage of the shipping concerns than a measure for the extension of German foreign trade, of German economic life in general, which without a speedy reconstruction of the German merchant marine would have to pay millions of marks yearly to foreign countries, if any even approximately sufficient tonnage be put at its disposal at all, considering the scarcity of ocean-going vessels.

German shipping firms will have to apply every possible energy and influence in order to reconquer their former place in the sun. As things are situated there need be expected no handsome dividends for years to come, even should the high freight rates now prevailing be paid for any considerable time after the war, which possibility is justly doubted in shipping circles. The profit of the first few years will in all likelihood be appropriated, for the most part, for the immediate payment of the obligations assumed during the war and for those to be assumed for the reconstruction of ships, as well as for the completion of the reserve funds, which naturally will have to be put to considerable use.

* Translation of an article by Oskar Linder, of Hamburg, in *Norddeutsche Allgemeine Zeitung* of March 31, as printed in *Commerce Reports.*

New Orleans Trains Navigating and Engineering Officers for America's New Merchant Marine

BY MEIGS O. FROST*

WHEN the average citizen learned recently that present construction plans for the new American Merchant Marine called for more than 8,000,000 tons of new shipping to be completed within two years, he had absolutely no realization of the problems involved. Huge as was the physical problem of building 8,000,000 tons of new shipping, a problem equally great was the training of officers to command that fleet. Not merely navigating officers but engineering officers as well. And in addition to this came the problem—equally great—of training merchant marine crews.

Since the days when the American clipper ship went out of existence, the United States did not lose merely the commercial supremacy of the seas. She lost as well her deep-sea ideals, and the United States Shipping Board was confronted with the problem of officering and manning the huge fleet that America needed to win the war from a people whose thoughts were the thoughts of landlubbers.

Maritime statistics at the beginning of the world war in August, 1914. showed America second to Great Britain, with the 7,928,688 tons of shipping under the American Flag. But of that tonnage accredited to the United States, only approximately 2,000,000 tons was available for deep-water service in the Atlantic. Those bald tonnage figures show, as nothing else, the huge maritime problem that confronted America.

The United States Shipping Board faced that problem and solved it.

Three days after Henry Howard had been sworn in as director of recruiting service for the Board on May 29,

* Special Agent, U. S. Shipping Board Recruiting Service.

1917, the first free United States navigation school in America was opened with the twenty students at Harvard University. The work of organizing additional schools went steadily on through succeeding months until forty-one in all were established on the Atlantic, Gulf and Pacific Coasts and on the Great Lakes.

Shipping Board representatives, coming to New Orleans, found the South's ancient seaport peculiarly in a mood to co-operate. The shipbuilding idea had permeated completely New Orleans' commercial life. Just

Commodore Ernest Lee Jahncke, Chief of Gulf Section of U. S. Shipping Board

across Lake Pontchartrain from the city, to-day, the hulls of a fleet of wooden merchant ships, exceeding 3,000 tons each, are nearing completion. Contracts have already been awarded for 5,000-ton steel freighters.

The city of New Orleans had just completed arrangements for financing a huge ship lock, an industrial basin and canal, in which additional fleets were to be built within the city limits and launched by the banks of the Mississippi River.

So New Orleans turned wholeheartedly to the Shipping Board's plan of training navigating and engineering officers and crews for America's merchant marine.

Rapid Expansion of the School

The United States Shipping Board Free Navigation School was first established in the offices of the Association of commerce. Swiftly it outgrew these quarters. The moment these cramped conditions were noticed Mayor Martin Behrman offered the Shipping Board a complete two-story building belonging to the city. This structure, the old Conveyance and Mortgage Building, was completely renovated under the direction of F. A. Christy, city architect, and March 1, 1918, saw the school housed in a building of its own. This gave New Orleans the distinction of being the only city in America to devote an entire building to the Shipping Board Navigation School.

Commodore Ernest Lee Jahncke was named by the U. S. Shipping Board as chief of the Gulf Section. For years he had been a leader among Southern yachtsmen. His title comes from his post as Commodore of the Southern Yacht Club, next to the New York Yacht Club, the oldest organization of its sort in America. He is a former president of the New Orleans Association of Commerce. Out of Louisiana's waterways the house of Jahncke has made its fortune. Commodore Jahncke has built the great shipyards now in operation at Madisonville. There to-day four 3,500-ton steamboats built of Southern pine are on the ways, and are close to the launching date. But despite the tremendous pressure of his private interests, Commodore Jahncke has accepted the post of Gulf Section Chief at the nominal salary of $5 per month.

Captain Ernest E. B. Drake, a deep-sea sailor, holding a master's certificate in the American merchant marine, accepted the post of director of the U. S. Shipping Board Free Navigation School. His assistant is Walton Smith, another practical deep-sea navigator. Those men, since the opening of the school, have poured a steady stream of qualified navigating officers into the American merchant marine. Their record is best summarized by one official report: not one man whom they have sent up from their school for examination before the U. S. Steamboat Inspection Service has failed to win his certificate.

The School Work

The navigation school is open from 8 a. m. until 11:30 p. m., daily. There is no set graduation day in that school. Each candidate for a mate's or master's certificate gets preliminary examination and individual instruction according to his needs. Ship models, compass, sextant, chronometer and patent log—all the equipment of a deep-sea navigator is available for instruction in that school. No man enters the school unless he has had two years' deep-sea experience. Within six weeks from his entrance, by this intensive system of instruction, each candidate has been thoroughly grounded in the basic principles of deep-sea navigation.

The work of the school is not, however, limited to the class room. Commodore Jahncke's gift to the school is the $60,000 (£12,300) steam yacht *Reverie*. This 130-foot craft, moored at the Southern Yacht Club on Lake Pontchartrain, makes regular trips into the Lake with classes from the Navigation School. There, out of sight of land, students of navigation get practical experience, under Captain Drake and Instructor Smith, in "shooting the sun," with sextant, in computing position with chart, chrono-

Entrance to U. S. Shipping Board Free Navigation School at New Orleans

Capt. Ernest E. B. Drake, Director of U. S. Shipping Board Free Navigation School, New Orleans, Instructing Class on Compass Deviation

meter and patent log, and are given exactly the training they need for their work later while crossing the Atlantic.

The number of students enrolled in the school varies. It maintains an average of between forty and fifty men.

While the navigating officers are being trained in downtown New Orleans, American marine engineers are getting their training necessary to obtain certificates as chief or assistant engineers out at the engineering school at Tulane University. There, under Professor J. M. Roberts, daily and nightly classes are put through a course that qualifies them for services in the engine rooms of ships crossing the Atlantic. All men permitted to enter this free engineering school must have had previous experience as firemen on ocean or coastwise steam vessels, as oilers or water tenders, as chief or assistant engineers on lake, bay, sound or river, as locomotive or stationary engineers. Or they must be graduates of nautical engineering schoolships, of technical school mechanical engineering courses, or must have served three years as apprentices to the machinist's trade. Approximately 30 men are constantly studying in these engineering classes in New Orleans.

Training Ship Assigned to New Orleans

New Orleans has also been assigned a training ship in which crews of the merchant marine are to be trained. The Shipping Board has not yet selected the craft which will be used in New Orleans, but word of this is expected daily.

In addition to these facilities for training men for the merchant marine, the United States Shipping Board Free Navigation School has been designated officially as a Sea Service Bureau. This means that graduates of the New Orleans school do not find themselves on the pavement hunting a job when their course of training is completed. The moment they are awarded their certificates as master or mate, engineer or assistant, they are assigned to duty on ships specified by the U. S. Shipping Board.

New Orleans since the earliest history of America has been a great seaport. Millions of tons of world trade have crossed the wharves of the 200-year old city. And now in the war crisis which has made an American Merchant Marine an imperative need if the United States is to play its part, New Orleans is working heart and soul not only to build ships but to train navigators, engineers and the crews who will officer and man them.

How to Order Pipe Fittings

In ordering fittings people not used to doing so can get into trouble by using terms unknown to the trade. If an inch tee is ordered, no mistake is possible; but these are made of cast or malleable iron, brass or steel, so it should be stated which material is wanted.

If what is known as "bull head" is wanted, the "run," as it is called, should be given first, then the outlet at right angles to the run, thus—1 inch by 1½ inches by ½ inch. There is another fitting which is virtually a tee but is not called so. It is one in which what is called the run differs greatly in sizes, say ¼ inch by 1½ inches by 1½ inches. This is called a 1½-inch ell with a back outlet. Ells can be obtained with side outlets. A sketch, however, with sizes marked thereon should be sent if there is any doubt in the mind of the one ordering.

Research in Marine Engineering*

How Lack of Research Has Retarded Progress in Marine Engineering—What It Can Accomplish

BY A. E. SEATON†

MARINE engineers have before them at all times and places certain phenomena—some familiar, others uncommon; these all have their causes and they themselves are generally effects. To understand them correctly more evidence is necessary than is generally supposed by the casual observer. It also often happens that among these engineers are men quite competent to observe and note all the facts and tender quite good evidence respecting them, but who are not so well fitted to arrive at the correct inferences to be drawn. But even if the means were available the men suitable for the work were not to be had; for those possessed of scientific knowledge and having had the necessary experience were generally too much engaged in following the avocation by which they lived to give the time necessary for laborious and patient research, without which the truth is sought in vain. Consequently we find many instances where important inventions have been conceived in the past, and even in some cases tentatively experimented with, but not brought to the perfection necessary for practical use until years afterwards, when the inventor and his supporters were beyond reaping any benefit from them, and all for want of diligent inquiry or examination in seeking the essential facts and principles involved in them. It will, therefore, be instructive to take a few well-known cases with an immediate reward for those who adopted it.

Development of the Screw Propeller

The screw propeller was proposed by Bramah as far back as 1785; it was tried by Littleton in a boat in 1794; fitted by Shorter to H.M.S. *Dragon* and *Superb* in 1802; but it was only dealt with seriously as a practical method of propulsion in 1836 in the steamship *Archimedes.* In H.M.S. *Rattler* in 1843 it was subjected to some further research by the naval authorities, which was carried out in such admirable, if costly, ways as to at last convince the public of what they might possibly have known fifty years before.

Now these *Rattler* experiments and many others made subsequently by the naval authorities with screw propellers are still sufficiently interesting and instructive to repay the student for examining them anew. It is certain that had they been examined anew in 1877 there would not have been perpetrated such a fiasco as happened with H.M.S. *Iris* in 1878.

No one, even with patient research, can now estimate the loss sustained by this country alone due to the dilatoriness in the "search for the truth" respecting the screw propeller which might have been employed for oceanic steamships with great advantage many years earlier than was actually the case. Nor can we have a true conception of the waste of fuel which went on year after year after the screw propeller was adopted from want of sufficient knowledge to design propellers so as to obtain the highest efficiency. Nor, on the other hand, can we estimate the great gain already actually attained by the patient, continuous, and scientific research made in this country and America, by means of experimental tanks, by the Froudes and other members of this Institution whose contributions are lasting monuments to their skill, diligence, and pertinacity in research.

Again, *the compound* engine, conceived by Hornblower in 1771, and improved by Wolff in 1804, was not fitted on shipboard till 1854 by Randolph and Elder in the *Brandon,* and in 1863 in H.M.S. *Constance.*

Another ten years elapsed before it was adopted for general purposes, and then somewhat grudgingly. This was really for want of something like true scientific research as against what passed muster for it, as may be seen in the Transactions of this Institution. There was later on a similar controversy and much heartburning over the triple compound engine, although it was introduced by so competent and scientific an engineer as the late Dr. A. Kirk in the steamship *Propontis* in 1874. Ten years later it was still being treated with considerable reserve.

Tardy Adoption of Triple Expansion Engine

The research conducted with patience and skill by Sir Alexander Kennedy, however, was sufficient in the end to break down prejudice and remove all opposition. Had such work as his been carried out thirty years before on similar lines with the *Brandon,* enough money could have been saved by the economy effected in fuel consumption alone to have gone far to pay the interest on the old National Debt. Besides, think how much mental energy was wasted in villifying systems such as the various compound engines, which real research could have rescued from the prejudice of opponents!

The surface condenser was part of Cartwright's patent of 1794, and also of Brunel's in 1822; it was, however, only in 1837 that Samuel Hall got one tried in a practical way in the paddle steamer *Wilberforce,* and also on the paddle steamer *Sirius,* the first steamer to cross from England to America. But a year or two after the surface condenser was laughed out of existence on grounds which, had proper research been made, would have been easily proved to have no real foundation for condemnation. For want of it, however, a quarter of a century after, both naval and mercantile ships were being still fitted with jet condensers, and years after that cross-channel steamers had them instead of the surface condenser now in universal use, and said to be able to effect a saving of fuel in those days of 15 percent. Think what that would have amounted to if the surface condenser could have been in general use from 1837 onwards!

Methodical research respecting the surface condenser has since then been carried out by Mr. D. Morison and Messrs. Weir, and has resulted in developments in its construction and use that have improved the power and efficiency of marine engines immensely.

But perhaps the most notable instance of delay in benefiting by an invention is that of the *steam turbine.* Branca so long ago as 1630 published the idea that a jet of steam impinging on the vanes of a wheel would make it revolve. He thereby established the foundation of the impulse turbine, just as Hero of Alexandria had so very much earlier

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* Read at the spring meetings of the fifty-ninth session of the Institution of Naval Architects, London, March 21, 1918.
† Member of Council.

discovered a reaction steam turbine and employed it for useful purposes.

It was not, however, till two hundred and fifty years after Branca that, while Sir Charles Parsons was making his first experiments with the reaction turbine, De Laval, a distinguished Swedish engineer, followed Branca's idea and made an actual impulse turbine. But even then he apparently failed at first to appreciate Branca's art in placing the nozzle, which was in the form of a human mouth, far enough from the vanes to permit of sufficient expansion before impact. By further research De Laval discovered why his first nozzles were so inefficient, and consequently found how to make an efficient impulse turbine.

Where Research Would Have Helped

Why no engineer or scientist perceived that expanding steam had no other virtue than that due to pressure must, I think, have been really from want of proper research and perhaps also from the contentment that comes of a good sedative phrase or aphorism. Our forefathers were told by some wiseacre that "Nature abhorred a vacuum"; they believed it, and, what is more, acted on it by applying vacuum-making engines to pump water from mines, and succeeded.

And when another genius arose in Birmingham who discovered that a grindstone crank handle might be moved round by a reciprocating instrument, the mill engine came into use; and finally the marine engine appeared, like the mill engine, in the form of a modified pumping engine, notwithstanding that a direct-acting engine had been used in one of the earliest attempts at steam propulsion (the *Charlotte Dundas,* in 1802).

It is true that many quite early (1787) attempts were made to rotate a shaft direct by a rotatory engine, but they were all of them designed to be worked by the pressure of steam, and none by the dynamic energy of it on expansion. In other words, they were all of them pressure and none of them velocity engines.

Having shown what want of research has failed to do, I will now venture on what may be called the positive evidence of the proposition.

It was by research that James Watt, himself not originally an engineer, made the discoveries that led to the great improvements he effected on Newcomen's engine, and later on by the same means he made further on his own designs even greater ones. It was by research that Stephenson's *locomotive* was transformed from being so extravagant in consumption of coal that even among collieries it could not work profitably into the engine as we know it to-day, for in all essentials there is very little difference between those engines and the locomotive of Stephenson's latter days.

Watertube Boiler Invented by a Doctor

The watertube boiler was the invention of Goldsworthy Gurney, himself a doctor, who made a very extensive and complete study of the instrument by which steam could be rapidly and safely generated and yet so light as to be carried on a road vehicle. His research is shown by his various patents, and the success of his road carriages marks how good most of them were. It was unfortunate for him and for us that this research was late in fructifying in the minds of others, for Parliament in 1835 (and we should remember it was an early Act of the Reformed Parliament) decided, against the evidence of experts, that four miles per hour was the safe limit of steam road-cars, and that a man in advance with a red flag was a necessary accompaniment. But for this Act motor cars, busses, and wagons would have been in general use before the railways were made.

The submarine, with which we are now so much concerned, is the result of long continued research. It is a far cry from Bushnell's and Fulton's early efforts of the beginning of last century to the wonderful submarines of the present day, and many were the steps from the crude attempts of those early days to the successes of to-day and many brilliant minds were at work upon the problem in the principal maritime countries of the world. Nordenfeldt and Garrett in England, Goubet, Zédé, and Laubeuf in France, Holland (the Irish schoolmaster) and Lake in America, Laurenti in Italy—to mention only a few of those who have contributed to solving the problem of submerged navigation—were all men whose success was largely due to an incurable thirst for that knowledge which is acquired by patient and diligent search.

The torpedo, an old idea in conception, was taken up seriously by a landsman, Whitehead, who by his research and perseverance made such a success of it that it was quickly added to the armament of our foreign navies.

The Steam Turbine

To Sir Charles Parson's perseverance and tenacity of purpose in carrying on methodical scientific research is due the practical and commercial success of the steam turbine. In friendly competition with him De Laval, Rateau, and Curtis have conducted research with the impulse turbine, and it is only by such means that they have attained success. Later on Sir Charles Parsons developed the idea of reducing the rate of revolutions of screw propellers to obtain high efficiency in them without reducing the rate of the turbine, by connecting the driver to the driven with toothed wheel gearing. The higher rate of revolution of the turbine now possible with such an arrangement has much improved its efficiency, so that the little loss due to the modern gearing has been much more than made up by the gain in general efficiency of the system.

By continued research other engineers have made the further improvement of double gearing whereby with a rate of revolution of screw as low as that obtaining in the large cargo steamer, the turbine itself may be run at as much as 4,000 revolutions per minute.

The balancing of reciprocating engines, initiated by Sir Alfred Yarrow, has by scientific research been made a fine art, with great advantage to all having to do with ships, and it was the means of evolving the four-crank self-balanced engine so much preferred in passenger and naval ships until the turbine superseded it for express services.

It will, perhaps, be an additional inducement to give scientific research its due if I go further and furnish an instance of how wrong things have been followed up at a great expenditure of time and money, most of which could have been certainly saved if the research had been methodical and scientific.

Of this waste of time and money, the so-called *hydraulic propeller* is a good example, for if a fraction of the money spent on this device had been devoted to a "diligent inquiry of the truth," the remainder could have been saved. The patent fees alone spent on proposals of this kind of propeller would have gone a long way to that end. But it was only after the Admiralty had fitted a small ironclad ship with Ruthven's internal propeller and demonstrated thereby how lacking it was in efficiency that the public could be convinced. Even then another and more costly form was tried some time after by the Dutch with equally disappointing results.

A shipowner once complained to me of the extravagance of his superintending engineer in spending $3,400 (£700) in one year on experiments which had been mostly failures. My advice to him was to let him spend much more, for, seeing there were seventy steamers under his supervision, it was more important for him to discover what things were wrong to have on shipboard, and avoid them even, than to ascertain those which were good. He could generally find out all about the latter without troubling himself to make special experiments.

My object, therefore, is to concentrate attention now on this research work as being not only necessary and interesting, but really remunerative in results and of great benefit both to the individual and to the public at large, and to show that it may be so even when the results are negative in character. Further, to ensure that, in future, research work shall not be left entirely to unaided and individual effort, or even to the collective effort which in the past has been only too often unmethodical and sporadic because unguided. To avoid this there must be found the means, the men, and the machinery for the following objects:

Objects to Be Sought

(1) Individual efforts and enterprise shall be encouraged, and when found to be in the right direction they may be assisted so as to be carried to a successful issue without loss of time.

(2) All individual efforts shall be as far as possible co-ordinated and combined, so that by united action higher efficiency and quicker development in practical results may be attained in solving each problem dealt with at the least cost.

(3) Definite and systematic study of each and every proposition that the marine engineer is faced with should be made in such a way as to be free from all personal prejudice or interest, and its development be proceeded with.

(4) To study the possibilities of every project with a view to the public good, so that inventions, or even mere ideas, when proposed may be examined with care, and tested by means which are wanting to the originators, whereby they may be dealt with adequately.

(5) To examine afresh many of the accepted axioms, aphorisms, and formulæ which now pass muster for use in marine engineering, in the light provided by modern knowledge, and by methods found successful in later years, in order to prove if they have been established and still remain on sure foundations or otherwise.

(6) To examine afresh the proposals and ideas contained in the old patent and other records with a view to winnowing from them the seeds of things which may now be cultivated and made to produce fruit, but which, when they were first proposed, could not be done from want of the means of manufacture.

If research can accomplish these things for us, it will amply repay any reasonable sum spent on it, just as it has done in other fields where it has been properly applied, although they were far more restricted than are ours. In the meanwhile, however, we can perhaps, with the greatest advantage, follow on the sound and practical lines adopted by Sir Alexander Kennedy with such marked success a few years ago. We can at the same time avail ourselves of the extensive installations in the physical laboratories of our colleges and technical schools to carry out many investigations, and do much useful work. Such investigations of various kinds have already been carried on in many of them with advantage, but for want of co-ordination they have not been always so productive of engineering good as they might otherwise have been.

While on this topic, it may be well to warn you not to expect too much from experiments with models of engines or of any machinery on too small a scale, for defects which, in them, will be practically microscopic may and often are in the real thing, when in use, a great and overwhelming cause of trouble. With a suitable and efficient staff and the necessary means, a school of marine engineering research should be available for practical investigations on shipboard as well as on shore, whereby shipowners could have their troubles investigated and the efficiency of their machinery tested, whenever occasion demands, in ways impossible by the ordinary engine-room staff, from want of time that can be diverted from their regular and necessary duties to that required for such work. Moreover, there is the difficulty arising from their inability by both training and temperament to act with sufficient and critical discrimination, so necessary for it to be carried out thoroughly.

The work done at home in the ordinary physical laboratories can be made more useful and instructive than hitherto if directed from one sympathetic center which can co-ordinate the results obtained, and which, when necessary, will subsidize the work.

In our educational establishments there is, however, and I suppose must always be, "the daily round and common task," required not only by the educational authorities, but such as is necessary for so training the students that they may acquire proficiency in the rudiments as well as in the methods of research.

Real research does not in itself amount to much, but I venture to think that, such as it is, it might do so if directed by a special authority to ensure that the investigations are carried out in a systematic way, and that all are co-ordinated so as to afford complete evidence by which to arrive at correct conclusions. Moreover, in making these investigations the pupils will, I believe, be more interested and probably learn more from them than by merely following the stereotyped courses usually followed by order of the governing authorities.

Research Work Should be Directed by Special Authority

Of another thing we may be pretty certain: that in these days of strenuous and unremitting work research can no longer be left in the hands of those engaged in manufacture or professional work of the ordinary kind, nor indeed are many of these best fitted by temperament and training for the patient, methodical work required for investigations. But they are, however, eminently fitted by their knowledge, experience, and daily occupations to direct and control such work as is necessary for the administration, both monetary and otherwise.

That so many inventions have been made by men not of the profession nor previously engaged in engineering work, seems to me convincing proof that the class of mind best suited for research and discovery differs largely and fundamentally from that which in other men succeeds in directing successfully all kinds of work, men, and other operations. Hence I suggest the differentiation indicated above. Bramah was a blacksmith and maker of locks; George Stephenson was a fireman; "Screw-propeller" Smith, the man who patented a good workable propeller and got the *Archimedes* built, was a farmer; Samuel Hall was in the lace trade; Goldsworthy Gurney, a doctor. The inventor who exhibited an internal combustion engine a hundred years ago at Cambridge was a parson, as was also Ramus, the inventor of the hydroplane ship; James Watt was an optical instrument maker; the inventor of the chronometer, and winner of the

King's prize for it, was a gardener; "Increasing-pitch" Woodcroft was a librarian; Bessemer was an artist; Armstrong a lawyer; and even in our own day we have had very many valuable additions made to our knowledge by men outside the profession, which all goes to show how much more liberal we are than the members of those other professions who would monopolize that adjective for their own.

For administrative purposes, therefore, such a committee as that over which I have the honor to preside* would be a very suitable one, consisting as it does of members of every branch of the marine engineering profession, selected by the various institutions interested in marine engineering progress, and having on it also representatives of such bodies as the Board of Trade, Lloyd's Register, the Bureau Veritas, and British Coroporation. To them might be added with great advantage representatives of the Admiralty, the Indian and Colonial Governments.

A suitable staff with a director at its head would be also necessary; but I do not propose to deal with such details, as for the present I am chiefly concerned to win from you the acceptance of the principle that there should be some definite body to take up seriously the direction of the work of research in all marine engineering matters, and further that there shall be no longer any delay in forming such a body *ad hoc*.

British Research Department

Many of you no doubt are aware that an important Government Department was constituted in 1915 under the title of "The Committee of the Privy Council for Scientific and Industrial Research," and that it is assisted by an Advisory Council as well as by Standing Committees on engineering, metallurgy, mining, and other applied sciences.

A fund of one million pounds has been placed by the Government at the disposal of the Research Department to encourage British industries and to undertake research work generally, but so far I am not aware that any of it is earmarked or otherwise reserved for any undertaking that may be considered as marine engineering, notwithstanding that the importance of this branch of industry to British and Colonial maritime interests should entitle it to a considerable share of such a grant.

It appears, however, that it is proposed that certain bodies or associations in various localities representative of the local industries shall co-operate with the Council of Research, and that the cost of such research work as may be undertaken in this way shall be partly defrayed from the funds subscribed locally by parties interested in the results and partly by grants from the Government Fund equal in amount to the subscriptions. In this way marine engineering may possibly come in for recognition.

On the Main Advisory Council we find one of our distinguished vice-presidents, Sir Charles Parsons, and representing the Admiralty as assessor to it is another vice-president, Sir E. H. Tennyson d'Eyncourt; while on the Standing Committee on Engineering this Institution is directly represented by Sir Archibald Denny and indirectly by some of our members who represent other institutions interested in marine engineering.

We can be sure, therefore, that the interests with which this Institution is so clearly connected will not be entirely overlooked, and that to whatever use the funds thus furnished are put and whatever great opportunities are thrown open, naval architecture and marine engineering will have their fair claims for consideration fully satisfied.

* The British Marine Engineering Design and Construction Committee.

The Engineering Committee referred to above have furnished a list of subjects thought to be suitable for our immediate research in marine engineering. The field covered by this list is so wide and instructive as to emphasize all that I have said in support of the necessity for research in marine engineering, and I cannot do better than append it to this paper and commend it to your consideration.

Subjects for Consideration Suggested by the Advisory Council for Scientific and Industrial Research

1. *Marine Engines.*
   - (*a*) Consumption per indicated horsepower or ship horsepower of various types of engines.
   - (*b*) Accuracy of torsion meter experiments.
   - (*c*) Efficiency of gearing of various kinds between engine and line shafting.
   - (*d*) Limits of peripheral speed for gear wheels.
   - (*e*) Application of roller or ball bearings to marine engines.
   - (*f*) Lubrication of stern tubes.
   - (*g*) Best kind and shape of nozzle for impulse turbines.
   - (*h*) Superheat and its effect on cylinder materials.
   - (*j*) Cylinder cooling (internal combustion engines).
   - (*k*) Further investigation as to the value of water injections.
   - (*l*) Internal combustion turbine engines.
   - (*m*) Lubricating oil for high temperatures.
   - (*n*) Most efficient management of condenser cooling surface and extraction of condensed water.
   - (*p*) Air pump efficiency.
   - (*q*) Centrifugal pump efficiency.
   - (*r*) Feed heaters, efficiency of various types.
   - (*s*) Best methods of preventing lubricating oils from entering boilers.
2. *Marine Boilers and Fuel.*
   - (*a*) Direct coal burning on grate.
   - (*b*) Atomized coal dust firing.
   - (*c*) Oil fuel.
   - (*d*) Oil burners for boilers.
   - (*e*) Boiler tubes.
   - (*f*) Transmission of heat.
   - (*g*) Lagging of boilers and steam pipes.
   - (*h*) Mechanical stokers.
3. *Constructional Materials.*
   - (*a*) Metal for turbine blades, impulse or reaction, saturated or superheated steam.
   - (*b*) Mixtures of iron for internal combustion engine cylinders, valves, valve seats, etc.
   - (*c*) Casting under pressure.
   - (*d*) Gun metal: heat treatment of, etc.
   - (*e*) Non-corroding alloys.
   - (*f*) Bearing metals.
4. *Refrigerating.*
   - (*a*) Methods and application.
   - (*b*) Distribution of refrigerated air.
   - (*c*) Insulating materials.

A hole drilled in a piece of metal or a slit was good enough perhaps for wire and sheet metal gages before the micrometer came into use, but why stick to such obsolete methods to-day? Consider the blessing it would be and the trouble it would avert if all sheet and rod diameters were given in thousandths of an inch instead of by number, which means nothing. A great anti-slit and hole movement is urgently needed.

Letters from Marine Engineers

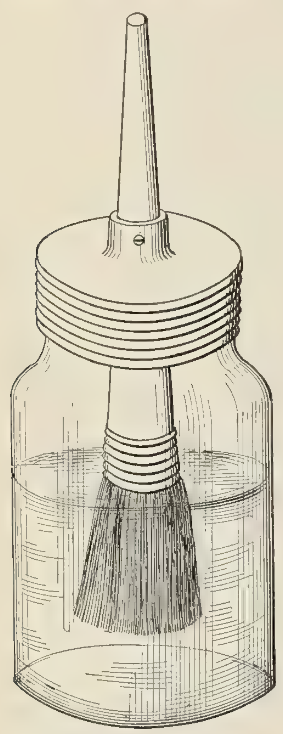
Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Shellac Container

In order to keep the bristles soft, the brush used for painting shellac must be kept immersed in the shellac when not in use. To leave the top of a shellac can or pot open means that the top surface of the shellac will at once become hardened over.

To cure these troubles try the scheme shown in the sketch. Buy a round, tapered handle brush; procure a



One Way to Keep the Bristles of a Shellac Brush Soft

quart Mason fruit jar with a screw top; drill a small hole about the size of the end of the taper handle in the center of the cover. Enter a taper drift from the inside, and with a light hammer form the bell or collar; then the brush handle is forced into this neck until it is in the position shown in the sketch. A couple of small head wood screws are used to secure it. This gives an excellent air-tight container. C. H. WILLEY.

Learn to Like Your Work

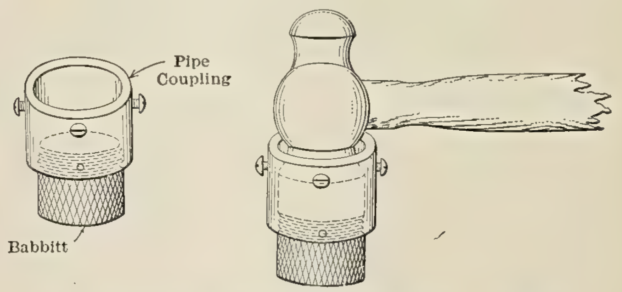
Some fellows look upon their jobs as merely an exchange of work for the dollars that are necessary to procure their bread and butter and other necessities. Too often their only thought is how much they can get for the least amount of effort. Often some men find themselves compelled to make good, and that compulsion proved a blessing; they had no idea that they could develop talent until thrown into the position of sink or swim.

Some men have the natural gift of grasping things, while others clumsily plod along, depending on the more intelligent to direct their efforts. It is easy to note those who like their work and find in it more than monetary returns. If you could have followed the big men of today from their humble start right on up the ladder to the top, it would be your verdict that they won because they loved their work and had an undying desire to master it. CHIEF.

Improvised Soft-Faced Hammer

This is a stunt that a traveling repair man showed to the writer; and while it is not as good as a regular soft copper or all-babbitt hammer, it does serve the purpose for which it was made. When a fellow has a whole raft of tools to carry, a kink like this that makes one hammer do the place of two is worth while.

The thing is made from a pipe coupling. Get one that will slip over the hammer face; drill and tap four



Arrangement for Attaching Babbitt Face to Hammer

holes for small round head screws, then set up the coupling in an earthen or clay mold, and pour it half full of babbitt about an inch over the top. The threads of the coupling serve to anchor the babbitt, but a small pin can be used to help.

Now you have a soft face for your favorite hammer and one which will not mar up brass or polished work. ASSISTANT.

Formulas for Determining the Sag in Wire Used to Aline the Bearings of Propeller Shafting on Board Ship

Piano wire of approximately 1/32 inch diameter is suitable for lining up propeller shaft bearings. It has a tensile strength of about 300,000 pounds per square inch cross-sectional area, so that a 1/32 inch diameter will support a 200-pound weight. The weight of this wire per lineal foot is .003 pound.

The curve made by the wire sagging is known as a "catenary"; but the formula for the sag in a catenary is most complicated and does not seem susceptible to arithmetical treatment, so that we have recourse to a formula for another curve, which, it is said, gives results almost

identical with those obtained from the formula for the catenary curve. This is the formula:

In which

$$h = \frac{W L^2}{8 \times W}$$

h = the distance of sag in feet, or parts of a foot, at the middle of the curve, measured *down* from the horizontal,
L = the distance (horizontal) between supports of the line in feet,
w = the weight in pounds per linear foot of the wire,
W = the tension in pounds endured by the wire, obtained by a weight suspended over a pulley,
8 = a constant.

As an example, let

L = 250 feet,
w = .003 pounds,
W = 200 pounds.

Then, applying these values to the formula given, we have:

$$h = \frac{.003 \times 250^2}{8 \times 200} = .117 \text{ foot,}$$

or 1.40 inches, closely. This is the sag in the center between supports, measured downward from the horizontal.

Now, to find the sag at any place other than at the center, the following formula may be used:

In which

$$y = h \times \frac{x^2}{(\frac{1}{2} L)^2}$$

y = the sag at any place, other than at the center,
h = the sag at the center, as found from the first formula given,
x = the distance in feet from the center the point of measurement is made,
L = distance between supports, as given in the first formula.

For example, suppose y is required when x is 10 feet, h = .117 foot and L = 250 feet.

Then

$$y = \frac{.117 \times 10^2}{(\frac{1}{2} \times 250)^2} = \frac{11.7}{15{,}625} = .000748 \text{ feet;}$$

but this must be subtracted from the .117 to get the distance sought, for the distance y is measured *upward* from a horizontal, whereas the distance h was measured *downward* from a different horizontal. So that

$$.117 - .000748 = .116252 \text{ foot,}$$

and 12 × .116252 = 1.395024 inches sag, 10 feet either side of the center of curve.

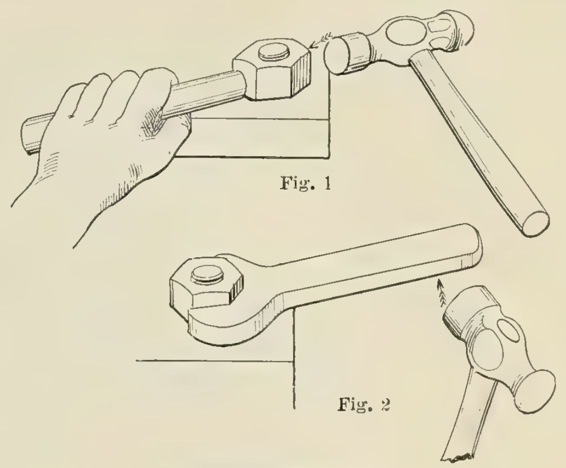
Scranton, Pa. CHARLES J. MASON.

Removing Frozen Nuts

At first thought, it seemed too much like kindergarten stuff to write up an article on how to remove stubborn or frozen nuts, but the writer thought: "Well, there are a lot of youngsters, firemen, oilers and beginners who read MARINE ENGINEER and they may get a pointer or two out of it." So after sketching away awhile and seeing that certain bits of information about how to tackle a stubborn nut could be illustrated, I batted out the following:

The first thing to do when you meet up with a nut that doesn't want to come off is to see if there are any extra threads sticking through, that is, any of the body of the bolt or stud. If so, these threads must be cleaned free of rust with a three-cornered file, or, better yet, if it is possible, take a hack saw and cut the top of the bolt or stud off flush with the nut. I have noticed many men neglect this point, and with a big wrench they would proceed to twist off Mister Nut, stud and all. It stands to reason that that part of the bolt sticking through, if in a place where it will corrode and rust, will become bigger than that part in the nut, thus the reason for following the above pointer.

After trying the above, if the nut will not start, try the method shown in Fig. 1, that of holding a piece of heavy

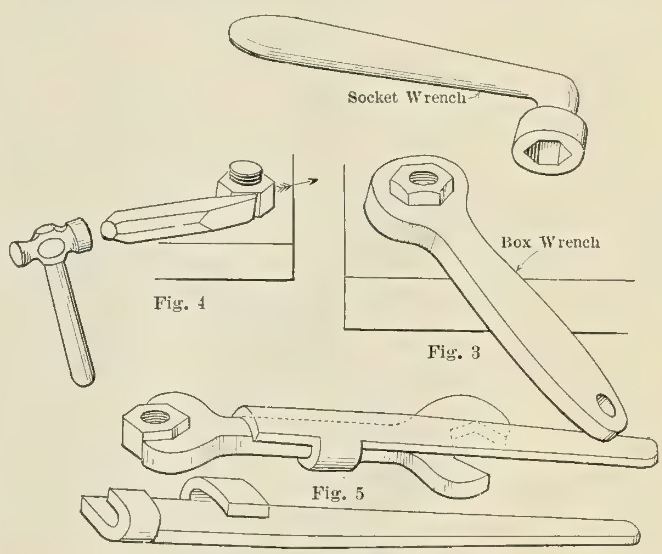


Loosening the Nut

stock against one side of the nut, and hitting jarring blows on the other side. Change the piece of stock around to another side of the nut and repeat the process. This rapping of the nut is in most cases very effective, and with patience the nut ought to come off.

After rapping, take a stout open end wrench and use as shown in Fig. 2. Set the wrench up against the nut good and solid and with a machinists' hand hammer strike sharp, smart blows.

The method of chiseling off stubborn nuts is a popular

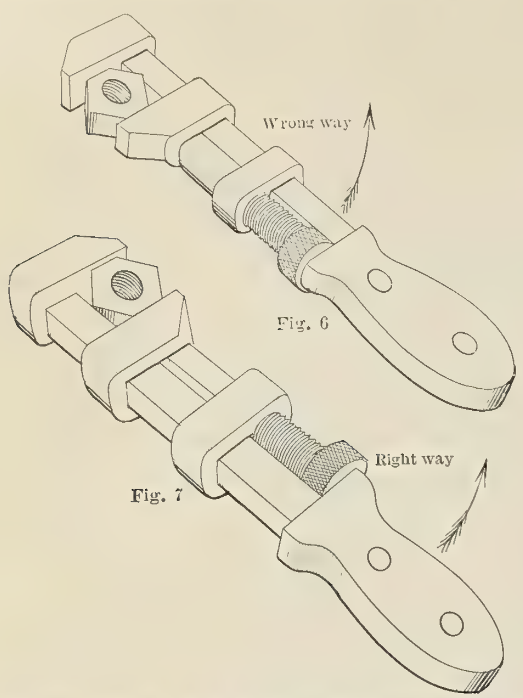


Chiseling Off a Stubborn Nut

one used by a great many engineers. A blunt tipped cold chisel is used at the angle shown in Fig. 4, and blows are struck that will drive the chisel against the nut in the direction shown by the arrow. This method is very effective but has the disagreeable feature of spoiling the nut for further use in a wrench and should only be employed where the nut is inaccessible to a wrench, or plenty of spare nuts are at hand.

To give added leverage to open end wrenches, there

are two means; that of flattening a piece of pipe so that a single-ended wrench will slip into it, and that of making a special lever for double-ended wrenches, as shown in Fig. 5. It should be remembered, however, that when one uses these extensions on the end of a wrench the



Right and Wrong Way of Using the Monkey Wrench

strength of one's muscles is greatly multiplied. If good judgment is not used, the stud or bolt will be twisted off.

The two types of wrenches shown in Fig. 3 are the best to use, if possible, on stubborn nuts, for they surround the whole nut, and, when working, grip the nut equally on all sides. They are especially adapted for use with the

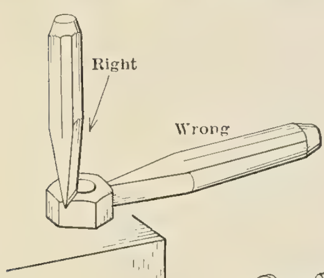


Fig. 9
TO SPLIT OFF A NUT

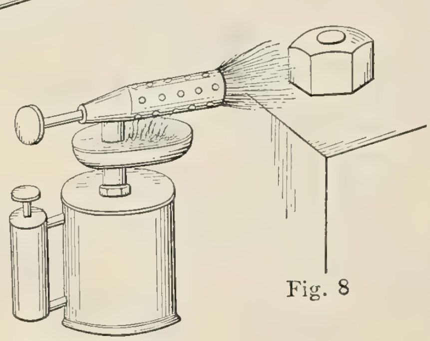


Fig. 8

The Last Resort

hand hammer, for they do not slip and chew the edges off the nut.

Figs. 6 and 7 show the right and wrong way to use a monkey wrench. These sketches apply to a right-hand nut. I have noted many good engineers use a monkey wrench the wrong way, and numberless times have I witnessed water tenders and firemen use one the way shown in Fig. 6. To cap the whole, they nearly always would be whacking it with a hammer. Monkey wrenches are good strong tools only when used properly.

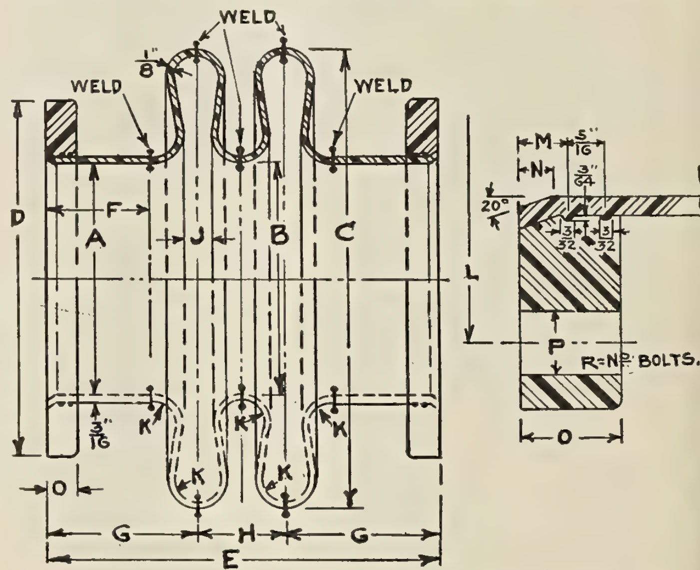
After trying these few kinks on the stubborn nut, there are but two methods left that seem worth while, that of soaking the nut and stud with kerosene (paraffin), and that of heating it with a torch, as in Fig. 8. Last of all, if it refuses to budge, it will have to be split off. There is a right and wrong way to do this. The wrong way spoils the threads of the stud or bolt and generally offsets it, due to the driving angle. The right way saves the bolt or stud and also gives a firmer backing up to the hammer blows.

Concord, N. H. CHAS. H. WILLEY.

Welded Steel Expansion Joint

The accompanying sketch and dimensions are for welded steel expansion joints for use in pipe lines passing through fuel oil tanks on ships and to compensate for expansion of the bulkheads.

Upon reference to the design it will be readily noted that this type of fitting is superior to the usual expansion



DIMENSIONS															
A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	R
$4\frac{1}{2}$	$4\frac{9}{16}$	9	$8\frac{3}{16}$	$7\frac{5}{8}$	$2\frac{1}{8}$	$2\frac{15}{16}$	$1\frac{3}{4}$	$\frac{11}{16}$	$\frac{7}{16}$	$7\frac{1}{16}$	$\frac{13}{32}$	$\frac{9}{32}$	$\frac{7}{8}$	$\frac{1}{2}$	10
6	$6\frac{1}{16}$	$11\frac{3}{16}$	$10\frac{1}{8}$	$9\frac{5}{8}$	$2\frac{5}{8}$	$3\frac{3}{4}$	$2\frac{1}{8}$	$\frac{7}{8}$	$\frac{1}{2}$	$8\frac{7}{8}$	$\frac{13}{32}$	$\frac{9}{32}$	$\frac{7}{8}$	$\frac{5}{8}$	12
8	$8\frac{1}{16}$	16	$12\frac{3}{8}$	$13\frac{1}{2}$	$3\frac{3}{4}$	$5\frac{1}{4}$	3	$1\frac{1}{4}$	$\frac{3}{4}$	$11\frac{1}{16}$	$\frac{17}{32}$	$\frac{13}{32}$	1	$\frac{5}{8}$	14

Dimensions of Welded Steel Expansion Joints

fitting with stuffing box, as the fact that the packing required setting up would only be detected from leaking when the tank is full.

Steel tubing expanded into steel flanges form the ends. The expansion rings are made on a form and of slightly thinner material than the ends. Joints made to the dimensions in the table were subjected to a water test pressure of 100 pounds. A. H. NOURSE.

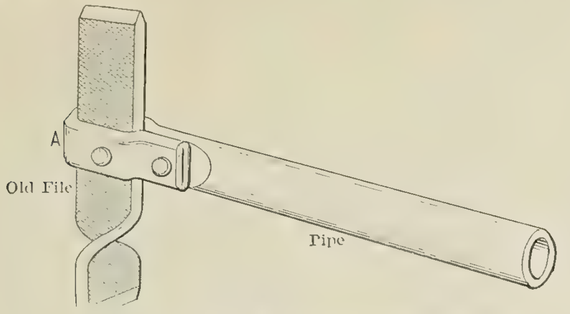
Brooklyn, N. Y.

Handy Scaling Tool

A very handy and inexpensive lot of scaling tools may be made from large size flat files that have become worn and unfit for further use and short pieces of ½-inch pipe. The file is heated cherry red and the tang cut off. A hole is drifted through the center of the file at *A* and while at a good heat the file is placed in a vise. With a

large wrench, it is given a 180 degree twist, as indicated at *B*.

Remember never to pound or work the file steel when the heat begins to darken. You will be liable to crack it if you do.



Scaling Tool Made from Large Flat File

The handle is made by flattening the end of the pipe for a few inches or more and forming the flattened part tightly around the file, lapping it back upon itself and then riveting it at both *C* and *D*. Sharpen both ends and the tool is finished.

Fireman.

Those Riveting Records

It would really seem that somebody should be saying something about these astonishing riveting records which are tumbling over each other in the daily press. We all know that for the winning of the world war the supreme demand is for ships. In the building of the ships the most responsible and the most continuously repeated operation is the riveting. Therefore, of course, speeding up the riveting is speeding up the building and increasing the output of ships.

It is, at first thought, most gratifying to note that a lively rivalry is current throughout the shipbuilding plants on both sides of the Atlantic for the making of riveting records, these being taken, of course, as indexes and guarantees of shipbuilding speed. They may be; but are they? It was said of the Charge of the Light Brigade that it was very brilliant but it was not war. So, without questioning at all the veracity of the current riveting records, we are tempted to say that they may be very brilliant but they are not shipbuilding, if indeed, they can be called riveting.

A shipbuilding pneumatic riveting record is not the record of one operative alone handling a single pneumatic riveter, even with changes or replacements of the tool from time to time. The man usually will be the head of a co-operating gang of six, comprising, besides himself, a backer-up, two heaters and two passer-boys. The making of a pace-making riveting record involves also many more than this riveting gang, who alone get the credit. As suggesting the mass of coincident work involved it is to be noted that the holes must be instantly and constantly ready for the rivets, so the numerous sheets and other members must be successively assembled and clamped in place with all the holes matching absolutely so that every rivet will enter without hesitation, and to make sure of this a plug must be tried in each hole and many of the holes must be reamed. These preliminary operations must all be carried on without getting at all in the way of the riveters. With all these conditions suggested to be complied with, and remembering the minor interruptions which inevitably occur, we are invited at the present writing to believe that in nine hours a single riveter has driven a number of rivets amounting to one every six seconds for the entire period. It paralyzes our believing apparatus.

It would seem to be very difficult for us ever to accept records of individual riveters, such as those now current, as assurances of ultimate shipbuilding speeds. Riveting records of another class are now coming along more deserving of serious consideration. These are the collective records per week, or other period, of all the rivets driven by all the riveters employed upon a single ship or upon a single shipyard way. This would tell us a real story of real shipbuilding, and the record would really tell not only of the actual performances of the riveters but of the co-operation of all hands to produce the desired results.—*Frank Richards in the Iron Age.*

NEW BOOKS

How Wooden Ships are Built. By H. Cole Estep. Size, 9 by 12 inches. Pages, 101. Illustrations, 200. Cleveland: 1918. The Penton Publishing Co. Price, $2.00 net.

While the art of wooden shipbuilding was not entirely extinct in the United States when the government undertook a year ago to build an immense fleet of wooden ships as a war emergency measure, nevertheless, the scarcity of men versed in this art created an insistent demand for practical information on how wooden ships are built. No books and very little literature on the subject existed, but the author immediately set about the collection of information and data covering current practice throughout the country. The result is a book largely descriptive of work actually being carried out rather than a scientific treatise of the subject. The mathematical theory of the ship design and other details which come more within the province of the naval architect than the shipbuilder have been omitted. The book describes the layout and equipment of wooden shipbuilding plants and the details and typical methods of construction of different types of wooden vessels as they are being built at the present time in the United States. As a supplement, two chapters on laying down wooden ships, from the treatise of the late Samuel J. P. Thearle, have been added.

The Naval Constructor. Fourth Edition. By George Simpson. Size 4¼ by 6½ inches. Pages, 880. Numerous illustrations. New York: 1918. D. Van Nostrand Company. Price, $5.00 net.

The new edition of this handbook is a repetition of the previous editions, except for the addition of some twenty-four pages of unity offsets of various steamers, a brief section of steam heating systems in ships and details regarding several new fittings and equipment.

Laying Off, or the Geometry of Shipbuilding. Second Edition. By Edward L. Attwood and I. C. G. Cooper. Size, 5¾ by 8¾ inches. Pages, 123. Illustrations, 121. New York: 1918. Longmans, Green & Company. Price, $2.00 net.

In the new edition of this standard text book, some portions of the text have been slightly revised with a view to greater clearness and some additions have been made. In particular, the solution of the hawse pipe problem has been modified so as to embody a theoretically correct method of projecting the generators of the cylinder. Several new examples have also been included.

Navigation. By George L. Hosmer. Size 4⅛ by 6¼ inches. Pages, 214. Illustrations, 43. New York: 1918. John Wiley & Sons, Inc. Price, $1.25 net.

This book has been prepared as an aid for candidates for officers' licenses in the American merchant marine. No theory or algebraic formulas have been introduced but only the simple working rules required for the daily routine of the navigator. The methods of computation have been illustrated by numerous examples.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY H. A. EVERETT

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number if from examination for grade of chief, and by a dagger (†) if from examination for other grades.

Examination Questions

Q.* (983).—(*a*) With a low pressure cylinder piston 72 inches diameter, 10 pounds pressure in receiver, 26 inches vacuum, what pressure is on the crank pin to push or pull?

(*b*) A boiler 10 feet long is placed athwartships. When the ship is upright on an even keel there is 10 inches of water in the glass. When listed 15 degrees, how far is the water above or below the original height in the glass?

(*c*) If a strong wind shifts from the bow to the quarter and sail is made fast, will the engine turn faster or slower? Will it use more or less coal? Does sail save coal or not?

A.* (983).—Assuming barometer is 30 inches or 14.7 pounds. Ten pound gage = 24.7 pounds absolute. 26-inch vacuum = 2.0 pounds absolute. (Approximate.) Net pressure per square inch of piston area = 22.7 pounds.

Piston diagram = 72 inches. Area = 4,070 square inches, therefore total pressure on piston and on crank pin at beginning and end of stroke is 22.7 × 4,070 = 93,390 pounds.

(*b*) If the original water level is at a part of the boiler where the sides are approximately parallel, the drop or rise of the water in the glass is equal to the half length of the boiler, multiplied by the tangent of the angle of heel, as may be seen by accompanying sketch (Fig. 1). This would be for the case given

$$\frac{10}{2} \times 12 \times \tan 15^\circ,$$

or

$$60 \times 0.268 = 16.08 \text{ inches},$$

which probably means that the water would surge from, "out of sight," to "full glass," were its action not restricted or damped by the smallness of the fittings leading into it from the boiler. It should be borne in mind, however, that if the level is originally in a part of the boiler where the sides are not parallel, as near the top, where it is usually placed, this will not be true, as the inclined waterline will not then pass through the intersection of the half length and the original waterline. Its location must then be determined by taking account of the other dimensions of the boiler. It will be something like the line shown dotted in the sketch, and the level in the glass will fall less and rise more than in the first case. This is because the total volume of water contained in the boiler remains the same, and so the volume of the added wedge *L″OL′* must always equal the volume of the subtracted wedge *W′OW″*. It is interesting to note that obtaining a reading by taking the mean of the levels in the water glass will always give a value higher than the true water level if the glass is located above the middle of the boiler. This applied directly only to boilers of the Scotch type.

(*c*) Assuming the throttle pressure to remain constant, the engine will turn faster. It will use more coal per hour but less coal per trip. The engine will turn faster, thus using more steam per hour and therefore more coal per hour, the ship is driven through the water at an increased speed and the coal per knot is less. The engine

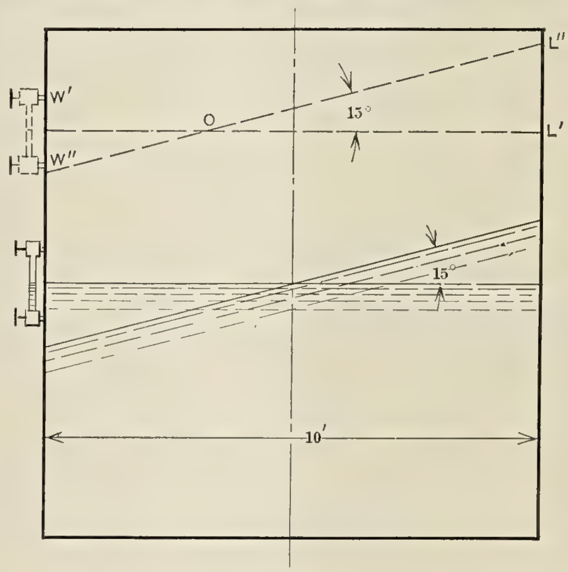


Fig. 1

will use more steam in about the proportion of the increase of revolutions per minute and the speed will increase also nearly proportional to the revolutions per minute. So that we have the engine working with an increase of power which has been proportional to the increase of revolutions per minute. To achieve the same increase of revolutions per minute, without the wind, however, would have required the engine to increase its power nearly proportional to the *cube* of the revolutions per minute. This difference of power is the gain due to the wind pushing on the sails and is equal to the pressure on the sails in the direction of motion multiplied by the speed of the ship, and divided by 33,000 if we wish to reduce to horsepower.

In actual practice, however, the effect is so slight that it is not worth the increased cost of maintenance, especially as with higher speeds of steamers the helping effect of the sails grows less.

Differences in Condensers for Reciprocating Engines and Turbines

Q. (981).—What are the differences in condensers for reciprocating engines and for turbines?

A. (981).—Mainly in details of construction. As turbines, of the condensing type, are designed to operate at higher vacua than reciprocating engines, the exhaust steam from the former has a greater volume than the latter. The tubes are so arranged as to allow little ob-

struction to the flow of steam; the area of the exhaust nozzle is made so as to distribute the steam most efficiently; the top rows of tubes are arranged so that the total clear space is approximately equal to the nozzle area. Also the horizontal cross section of the condenser are so designed as to give approximately a constant steam velocity from entrance to air pump suction and thus avoid a pressure gradient across the condenser.

Effect of Unbalanced Forces in Reciprocating Engines

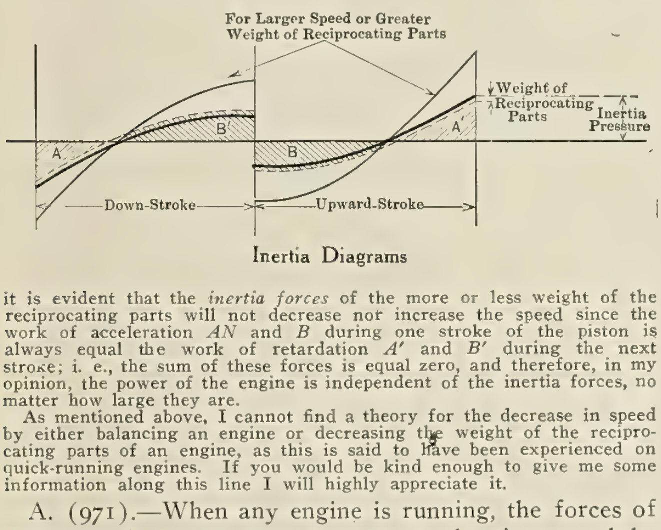
Q. (971).—(a) Assuming two engines of equal principal dimensions and arrangement which differ only in that the one is balanced by counterweights at the cranks, and the other not, will the former run at a greater number of revolutions to any appreciable extent or develop more brake horsepower?

(b) To make clearer what I am driving at, I desire to submit to you my analysis of this question.

An unbalanced engine sets up more or less vibration which is to be extinguished by the foundation, and which is, therefore, useless work or a wasted force. These free forces, prevented or reduced, as is the case on the balanced engine, should increase the power transmitted to the shaft.

(c) If the balancing of an engine is not desirable, but the weight of the reciprocating parts could be reduced, would such a step not tend in the same direction as balancing an engine? The free forces would be reduced and, therefore, we would approach the condition of a balanced engine. If this is the case, and the above assumption is right, then, by decreasing the weight of the reciprocating parts, the engine also will increase in speed. Am I right on that?

(d) Being unable to find a theoretical calculation of my assumption or to find a statement along my idea in the literature on balancing of engines, yet, as to account for such a possible increase of speed I also investigated the effect of the decrease in said weight on the inertia diagram. As an example, I assumed a vertical, single-acting (two-cycle Diesel) engine as being the simplest case, since every cylinder is alike and no valve motion is to be considered. But, looking at these diagrams,



Inertia Diagrams

it is evident that the *inertia forces* of the more or less weight of the reciprocating parts will not decrease nor increase the speed since the work of acceleration *AN* and *B* during one stroke of the piston is always equal the work of retardation *A′* and *B′* during the next stroke; i. e., the sum of these forces is equal zero, and therefore, in my opinion, the power of the engine is independent of the inertia forces, no matter how large they are.

As mentioned above, I cannot find a theory for the decrease in speed by either balancing an engine or decreasing the weight of the reciprocating parts of an engine, as this is said to have been experienced on quick-running engines. If you would be kind enough to give me some information along this line I will highly appreciate it.

A. (971).—When any engine is running, the forces of which are due to the *steam pressure* on the pistons and the load on the engine shaft are resisted by the stresses in the engine structure and are perfectly balanced, but the inertia forces of the moving parts caused by their continuous variation in direction and velocity are not automatically balanced, and unless cared for will set up vibrations. Balancing in engineering parlance is, therefore, the provision of means to neutralize these disturbing inertia forces. If the moving parts had no mass (or weight) these forces would be zero and the engine would still be perfectly balanced, but as they possess mass the unbalanced forces always exist. Rotating masses exert a continuous radial force due to the centrifugal force set up and reciprocating masses produce intermittent impulses in the line of reciprocation. If we balance these inertia forces (the first by equivalent rotating masses diametrically opposite and the second by equivalent reciprocating masses of opposite phase) theoretically the only thing which happens is that the shaking or vibration disappears and there is *no gain of power* whatever, for we have simply added inertia forces which neutralize those first called into existence, and neither the original forces nor their balancing forces were capable of doing useful work in rotating the shaft. This may not be obvious in the case of reciprocating parts, but consider that in one revolution you, on the down stroke, first accelerate the moving parts and then retard them and by nearly the same forces, but in opposite direction. If you take a complete revolution the sum of the acceleration and retardation for the two strokes is exactly zero. With this explanation, then, you will see that the answer to your first question is that theoretically the balanced engine will develop no more brake horsepower than the unbalanced engine for the same throttle pressure. Practically, of course, the elimination of lubrication troubles and other items, in addition to the elimination of vibration, make balancing desirable and necessary, and it is possible to run a balanced engine at higher speeds than an unbalanced one before the danger of breakage is reached. For example, a well-known automobile engine is advertised to give more power because it is balanced; but if you read the statement carefully the increase of power is obtained because *crankshaft distortion* has been eliminated by the balancing, and not any conversion of the inertia forces into useful work. The foregoing answers paragraphs (a) and (b) of your query.

Referring to paragraph (c), lightening the moving parts will have the same effect as partial balancing, but by balancing it is possible to eliminate vibration, while lightening reduces vibration, but cannot entirely eliminate it. As explained above, reducing the weight of the moving parts will not of itself increase the speed of power.

(d) The conclusion you reach here is quite correct.

Cooling Surface of Condensers Required

Q. (965).—Is the 2,000 square feet of cooling surface allowed in the condensers of the 1,500 horsepower vessels building for the Emergency Fleet sufficient? I think considerably more should be provided or the vessel will fail to meet requirements in service.

A. (965).—The allowance is sufficient, provided the plant is operated properly and the surface is well arranged in the condenser. One square foot per indicated horsepower is a rough working rule, which in the past has given ample surface for the general run of marine plants operating in all sorts of waters. Present practice in carefully designed units, arranged to avoid drenching of the lower tubes by the condensate from the upper and to direct the travel of the vapor, is to allow less surface than given above, even for very high vacua.

Radiation, Conduction and Convection

Q.† (975).—Describe radiation, conduction, convection.

A. (975).—Heat may be transferred from one body to another by three methods, radiation, conduction and convection, and usually all three methods are employed in the process, though each may exist separately. By *radiation* we commonly mean the heat or radiant energy which is propagated from the body in a radial direction by the ether vibrations; by *conduction,* the propagation of the heat energy by the *contact* of the particles; as the flow along a metal rod from hot end to cool end, and by *convection* the transfer of heat by means of some *conveyor,* as when a particle of air is heated from a hot body and then flows to a colder body and gives up its heat.

To illustrate, consider an object placed on a grid over a fire; it receives heat radiated (in straight lines only) directly from the glowing coals (radiation), also from contact with the hot grid on which it sets (conduction) and also from the hot gases which flow by it (convection). If it were on top of a closed stove the heating (from stove to object) would be by the last two methods only.

Shipbuilding and General Marine News

**Contracts for New Ships—Shipyard Improvements—
Engineering Projects—Improved Appliances—Personal Items**

FIVE NEW YARDS AUTHORIZED FOR BUILDING CONCRETE SHIPS

Programme Calls for 42 Ships, Adding 298,500 Deadweight Tons to the Merchant Marine

Five new yards for the building of concrete ships and the construction of a total of 42 new concrete ships have been authorized by the United States Shipping Board.

Of these 42 concrete ships contracts for 18 have already been given by the Emergency Fleet Corporation. Contracts for the building of the remainder will shortly be let.

These 42 concrete ships will nearly all be tankers of 7,500 tons each, with a capacity of 50,000 barrels of oil. Each of the 7,500-ton ships will have 2,800 horsepower and a speed of 10½ knots.

Others of the concrete ships are cargo ships of 3,000 and 3,500 tons. The 42 concrete ships will have a total of 298,500 deadweight tonnage.

Location of the Yards

The five new yards are to be located, respectively, at Wilmington, N. C., Jacksonville, Fla., Mobile, Ala., San Diego, Cal., and San Francisco, where the *Faith*, the first concrete vessel, was built. There are also two private concrete shipbuilding yards, one at Brunswick, Ga., the other at New York City.

Cheaper Than Wood or Steel

The estimated cost of building a wooden ship is about $165 a ton complete, and that of building a steel ship about $180 to $220 a ton complete. The estimated cost of concrete ships is between $100 and $110 a ton complete. The difference is, it is claimed, brought about by the saving in equipment, time, labor and material.

Merchant Ships Launched in May Total 344,450 Deadweight Tons

American shipyards building for the United States Shipping Board launched in May 71 hulls, totaling 344,450 deadweight tons. This is a new high mark for launchings in the United States.

There were launched in May 39 steel ships, totaling 228,750 tons, and 32 wood ships, totaling 115,700 tons.

The May launchings exceeded those of April by 26 ships, or 122,520 tons; of March by 31 ships, or 89,360 tons; of February by 40 ships, or 174,650 tons, and of January by 55 ships, or 231,900 tons.

They also exceeded the highest monthly average of the United Kingdom—that of 1913—by 102,931 tons, the monthly average of 1917 in the United Kingdom by 199,325 tons, and they are within 57,886 tons of the American launching totals for the entire year of 1901, the record pre-war year in American shipbuilding.

350,000 Men Now Listed as Shipyard Employees

Expansion of American shipyards is indicated by the fact that the number of shipyard employees had passed the 350,000 mark at the end of May. On October 7 the total number of shipyard employees was 106,900. In seven months, therefore, the number of workers has increased by over 200,000.

Daily attendance in the yards has also improved, as shown by a record attendance in March of 98 percent in the wood shipyards and 84.9 percent in the steel yards.

Satisfactory as this development has been it is, nevertheless, expected that the number of employees will be increased by at least another 100,000 by midsummer.

TWO NEW SHIPYARDS FOR GOVERNMENT WORK

Pacific Coast Yard to Be Built by Bethlehem Shipbuilding Corporation

Two new shipyards, one on the Atlantic and one on the Pacific Coast, will be constructed with capital furnished by the Emergency Fleet Corporation. Preliminary announcements regarding the proposed plants indicate that each yard will have ten shipways, together with its own fabricating, machine, boiler, forge shops, etc. The fabricating and manufacturing capacity of the country is so well taken up with work for existing shipyards that the plans are to create new facilities for fabricating ship steel and building turbines, boilers and all ship parts.

The Pacific Coast yard will be built by the Bethlehem Shipbuilding Corporation, Bethlehem, Pa., at Alameda, Cal., on San Francisco Bay. This yard, with ten shipways and complete shops for fabricating hulls and building machinery, will be known as the Liberty Plant. The Atlantic coast yard is being held in abeyance, pending the completion of arrangements for housing the workmen.

The vessels to be built in the new yards, it is said, will be of about 9.000 tons deadweight. The lists for equipment for the new yards are being prepared, calling for sixty overhead electric cranes for the shops of each yard, in addition to tower whirler cranes for the shipways. It is understood that about 200 overhead electric cranes will be required and an equal number of hoists. In addition to this, from 60 to 100 punches, shears and other fabricating machines will be purchased.

SKINNER & EDDY CORPORATION LEASES PLANT OF SEATTLE CONSTRUCTION & DRY DOCK COMPANY

Big Merger on Pacific Coast Effected on June 1—Combined Yards to Build Merchant Vessels Only

By leasing the shipbuilding plant of the Seattle Construction & Dry Dock Company, Seattle, Wash., the Skinner & Eddy Corporation of Washington has become the most powerful shipbuilding organization on the Pacific Coast. Under the new arrangement, made effective June 1, the Skinner & Eddy Corporation will have in its employ a total of 12,000 shipyard workers. The operation of the combined plants will be directed by David Rodgers, general manager of the Skinner & Eddy Corporation.

Immediately following the merger of these two great yards, the Emergency Fleet Corporation placed an order with the Skinner & Eddy Corporation for steel ships valued at $100,000,000, providing sufficient work to keep the combined plants in Seattle in continuous operation for more than two years. The Skinner & Eddy plant now has fifteen direct contract 8,800-ton steel steamships to build for the Emergency Fleet Corporation, and the Seattle Construction & Dry Dock Company has direct contracts for ten 7,500-ton steel vessels.

The two plants occupy adjoining sites, each plant at present comprising 27½ acres. It is understood that the Skinner & Eddy Corporation has plans for extensive improvements of the combined plants, although statements to this effect have not yet been authorized by the company.

Part of the work previously contracted for by the Seattle Construction & Dry Dock Company, which was controlled by the Todd interests of New York, consisted of Government contracts for battle cruisers and torpedo boats. The naval work will be transferred to the Tacoma plant of the Todd interests, so that the entire facilities of the Seattle Construction & Dry Dock Company can be devoted to merchant shipbuilding.

Hull Draftsmen and Hull Inspectors Wanted by the Shipping Board

Men competent to fill the positions of hull draftsmen or hull inspectors are requested to communicate with the offices of the United States Shipping Board at Cleveland. Men experienced in hull work will find an excellent opportunity to aid the Shipping Board in these capacities.

EMERGENCY FLEET CORPORATION NOW ESTABLISHED IN PHILADELPHIA

Moving of Offices of the Emergency Fleet Corporation from Washington to Philadelphia, Begun June 1

With the leasing of the upper stories of the building at 140 North Broad street, Philadelphia, as a permanent home for the Emergency Fleet Corporation, steps were immediately taken to move the office equipment of the various divisions, as well as the effects of the employees, from their headquarters in Washington to the new home in Philadelphia. On June 1, by means of a fleet of ninety army trucks, the moving of the office equipment was begun.

To facilitate the moving, forwarding orders were distributed among the various offices of the fleet corporation. A 30-page pamphlet, compiled and distributed under the direction of A. M. Taylor, gave a list of accommodations from which persons connected with the corporation who are to move may make selections.

SCHWAB TELLS STEEL MAKERS OF RAPID STRIDES IN SHIPBUILDING

Over 250,000 Tons Completed in May—Rate of Production Will Be Rapidly Increased in Coming Months

At the annual dinner of the American Iron and Steel Institute, in New York on May 31, Charles M. Schwab, general manager of the Emergency Fleet Corporation, announced that the United States had put into commission in the month of May over 250,000 deadweight tons of merchant vessels. This output he confidently predicted could be taken as a minimum and that the monthly output would steadily increase.

Bearing out this statement, he stated, "During the past week we have contracted for new work aggregating $200,000,000 or $250,000,000, that will increase the shipbuilding capacity of the United States by at least three millions tons a year, and we will double that if necessary. We shall produce during this year 400,000 or 500,000 tons on the Great Lakes alone; but I think that is not enough, and in the coming year we can expect at least 1,000,000 tons from the Great Lakes.

"Last January there were 60,000 workers in the shipyards of the country. Today there are 350,000 and another 350,000 in the engine, boiler and accessory works."

Hog Island, Pa., Now the Address of the American International Shipbuilding Corporation

All communications to the American International Shipbuilding Corporation should be addressed to Hog Island, Pa. The corporation states that it is very important that this address be used, as the Emergency Fleet Corporation has moved into the building in Philadelphia where the American International Shipbuilding Corporation was formerly located. Unless all correspondence for the American International Shipbuilding Corporation is directed to Hog Island, Pa., much needless confusion is likely to result in handling its corespondence.

ENGLAND TO BUILD TWELVE NEW SHIPYARDS

One Hundred Shipways to Be Constructed to Accommodate Fabricated Steel Vessels Up to 15,000 Gross Tons

Information was received in Washington on June 5 that England has decided to build twelve new Government-owned shipyards, which will contain in all 100 ways. According to the British plans, fabricated vessels of steel only will be built in the new yards. These vessels will be of 12,000 and 15,000 gross tons each.

It was stated that the new yards will be constructed in Wales. This location has been chosen so that the present shipbuilding programme of England, which is situated chiefly on the River Clyde, will not be interfered with.

Large Canadian Shipyard to Be Built

The Dominion Iron & Steel Corporation is to erect a large shipyard in Canada for building ocean-going steel steamships. The new plant will cost from three to five million dollars, and will be ready for operation in from fifteen to eighteen months.

Plans have also been made for the construction in Canada of a plant for rolling steel plates with an annual output sufficient to meet the demands of Canadian shipyards for years to come. At present, orders have been placed in the United States for 80,000 tons of steel for ship construction, in accordance with an arrangement made by the Canadian Government with the United States Government.

Concrete Steamer Faith's First Sea Voyage

According to a telegram received by Marine Engineering on May 29, the concrete steamer *Faith,* six days out of San Francisco, with a full cargo, reached Seattle on the afternoon of May 28, on her way to Vancouver, after one of the roughest voyages on the Pacific Coast. Although the vessel encountered an 80-mile gale and waves 35 feet high, everything on board the vessel came through in good condition. Both the captain and government officials on board declared that the concrete vessel behaved as satisfactorily as any well-built ship of wood or steel and with little or no vibration from the machinery.

The *Faith* is not only the first ocean-going concrete steamship to be built in the United States, but is as well the largest vessel of this type to be built in the world. She has a cargo capacity of approximately 5,000 tons, and was built in San Francisco by the San Francisco Shipbuilding Company.

AMERICAN SHIPYARDS TO CELEBRATE THE FOURTH OF JULY BY LAUNCHING VESSELS

Each Shipyard Striving to Have One or More Hulls Ready for Launching on Independence Day

In accordance with a suggestion by Edward N. Hurley, chairman of the Shipping Board, arrangements are being made at every shipyard in the United States to launch one or more vessels on July 4, in celebration of the birth of the nation's independence. Latest advices indicate that a total of eighty-nine vessels, with a deadweight tonnage of 439,886, will be launched on July 4. Thirty-seven of these, with a deadweight tonnage of 254,686, will be steel vessels, and fifty-two, aggregating 165,200 deadweight tons, will be wooden vessels.

Chairman Hurley's suggestion was made in ample time to allow the shipbuilders to speed up their production schedule so that at least one vessel from each yard can be made ready for its initial plunge into the water on that date.

The McClintic-Marshall Company to Build a New Shipyard

The McClintic-Marshall Company, now operating fabricating steel plants at Rankin, Leetsdale, Carnegie and Pottstown, Pa., will build, at the request of the United States Government, two new fabricating plants for ship material; one to be located at Leetsdale and the other at Pottstown. Each will have a capacity for fabricating 10,000 tons of shipbuilding material per month.

The McClintic-Marshall Company will also build a large shipyard on the site of the former plant of the Ellicott Machine Corporation, Baltimore, Md., which will be operated by the company for building fabricated steel vessels.

St. Louis Preparing to Build Ships

Preparations for building sea-going vessels at St. Louis, Mo., are being made, and a group of capitalists and business men is waiting the word from Washington, according to the *Maritime Register.*

The St. Louis district is now manufacturing every major ship part except the heavy forgings and has an 8-foot minimum channel to the Gulf. In recent years it has become a producing center of open-hearth steel engines, boilers and Diesel motors.

George J. Baldwin, chairman of the Board of the American International Shipbuilding Corporation of the great Hog Island plant, has told St. Louis capital that St. Louis materials now being used in his Eastern yard ought to be assembled into ships in St. Louis, and that the 3,500-ton cargo boats now being built in the Great Lakes yards could be taken down the Mississippi at all stages, and that the 7,500-ton ships for cargo and transport could be moved under proper conditions on 8 feet of water.

The first plant to be erected will be capable of building four 7,500-ton vessels at a time. It will cost $1,000,000, of which one-half has been subscribed.

Wood Ship Design to Be Altered

Some alterations in the new wooden ships built for the Emergency Fleet Corporation are to be made that these vessels may be better adapted to carrying bulk cargo, it was announced on June 5. The decision to make these changes was reached following a conference between Chairman Hurley, of the Shipping Board; Charles M. Schwab, director-general of shipbuilding; P. A. S. Franklin, of the operating committee, and Charles Piez, vice-president of the Emergency Fleet Corporation.

Mr. Franklin was appointed to investigate the matter in detail, and for this purpose to visit some of the yards. It is believed that by altering the hatches and probably making some changes on the interior of the new wooden vessels they will be adapted to carrying coal to New England. This is the trade in which the Shipping Board is anxious to place the new vessels.

Through the efforts of Mr. Franklin's committee a considerable increase in the coal carried in the New England trade has been effected. It was learned that the coal carried to New England by steamer alone during May was 100,000 tons more than during the previous month. In addition, the coal carried by barge also increased.

Concrete Barges to Be Built in New Chicago Shipyard

A new corporation, the International Constructors, has announced that it will build a new shipyard in Chicago, where concrete ships will be constructed. The yard is to be on the south branch of the Chicago River, about where Twenty-ninth street would cross if it were cut through. The site is near the head of the Sanitary Canal. Theodore Ahlborn is naval architect of the new firm. Paul Gerhardt, formerly county architect for Cook County, Illinois, is active in the corporation. Mr. Gerhardt and Mr. Ahlborn have offices in the Schiller building, Chicago.

A novelty is to be tried by the company in its concrete boats. The sides and bottom will be made much thicker in a ship like the *Faith*, and will contain buoyancy chambers in addition to steel reinforcing rods. No frames will be visible, as they will be replaced by connections between the inner and outer walls of concrete.

It is expected that the new yard will be finished in a month or six weeks, and work will then be begun on 94 barges, with 120 tons carrying capacity each, that are to be used in the inland waterways of Illinois. The barges will bring coal to Chicago from the mines of the central and southern parts of the State and will carry back materials for use in factories. The tows will be made up of the towboat and four barges. The engines will be of the semi-Diesel or producer-gas types. As soon as the plans were made known St. Louis shippers announced they would like to follow suit with a line of barges on the Mississippi and Missouri Rivers.

There are to be three ways at the yard, from which the ships will be launched sideways. Later it is the intention to build steamers for the Great Lakes. These concrete steamers will be 241 feet long. Plans for their construction are ready.

All work at the yard will be done under cover. Buildings are to be put up which will have one movable side. This will make it possible to work with concrete both winter and summer. Concrete "guns" will be used on the sides of the ships and the bottoms will be poured by the hydraulic methods.

Drift Bolt Driver for Special Work

While shipbuilders are bending every effort to speed up each step of ship construction, the builders of the tools that play so important a part have not been idle. Their task is the development of new and better machines, so that a few seconds may be cut from the time required for each operation.

The Ingersoll-Rand Company's latest contribution is an air hammer especially designed for drifting up bolts. This tool enables one workman to do in a

Drift Bolt Driver with Telescopic Air Feed

short time that which would otherwise be a relatively slow task, needing two men. There is also the consideration that the new hammer makes the work far less fatiguing.

The tool in question is styled Ingersoll-Rand No. CC-251 drift bolt driver. Its distinguishing feature is a telescoping leg or air feed. This portion of the device consists of two sections of seamless steel tubing, one of which slides within the other, and is provided with an air-tight cup leather. Air when admitted extends the tool until it is against the bolt to be driven, where it is firmly held by air pressure while the bolt is being driven. A single three-way throttle controls both functions of the tool.

The hammer element is identical with that of that other member of the Ingersoll-Rand line, the No. CC-25 drift bolt driver. The new tool is very powerful, and will drive bolts of 1½-inch diameter up to 10 feet in length. It weighs 90 pounds, is 55 inches in length when air feed is closed and 77 inches in length when fully extended.

In its special field it is of distinct advantage and should be a welcome addition to the air-tool equipment of the yards turning out wooden hulls.

Ten Million Dollar Marine Terminal to Be Built at New Orleans by the Government

Government plans for warehouses, docks and terminal facilities at New Orleans call for the expenditure of ten million dollars. The project, work on which will be begun at once, will include three warehouses and a 2,000-foot pier and warehouse on the river adjacent to the canal. It is hoped to complete the warehouse by November 1.

The improvement will be of value to New Orleans, not only in affording it facilities for handling a greater amount of army shipments but for commerce after the war.

Dry Dock and Shipbuilding Plant for St. John

The development of the harbor in Courtenay Bay, St. John, N. B., Canada, as specified in the original contract of the Dominion Government with the Norton Griffiths Company, of Liverpool, which was commenced in 1912, but suspended at the beginning of the war, is now to go forward under the transfer of the original contract to the St. John Dry Dock & Shipbuilding Company, a new company composed of prominent Canadian ship owners and builders. The total expenditure of the contemplated works is estimated at seven million dollars. According to Counsel Henry S. Colver, of St. John, the present scheme involves only necessary expenditure for harbor necessities, the dry dock and the establishment of the shipbuilding industry on a large scale.

It is understood that the new company is to build the shipyard and lay the keel for the first 10,000-ton steamship within twelve months. The dry dock is to be completed in three years. The number of men to be employed is estimated at 2,000.

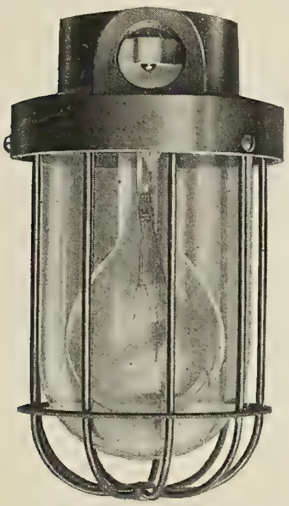
"Denison" Vapor Proof Fitting

The "Denison" fitting, illustrated, offers several new features for the exclusion of moisture, gases, etc. The dominating feature is the method of sealing the glass in the base. The seal is obtained by using a blown glass having an extended flange at the top. This flange is seated between two gaskets in a recess, which is formed in the base, and is pulled into position by means of a ring, which has co-ordinating threads which make up to the base, the recess being narrower than the thickness of the flange and the glass, thus compressing the glass firmly between the upper and lower gaskets. Instead of having a sealing surface of only the thickness of the glass wall, this seal is obtained between the two flat surfaces, to which great pressure can be applied, with the assurance, it is claimed, that it will be impossible for the seal to loosen or the glass to break with expansion. It is much the same principle as the standard "Union" fitting used in all marine work, except

Hoisting Engines Manufactured by the American Clay Machinery Company

no nicety of "fitting" is required, as the gaskets take up any irregularities that may exist between the several parts.

The ring or collar may be used as a shade holder for a reflector, as in the case of "Cargo" type of lighting unit, or for a guard, as shown in the cut. The wiring space is ample for all splices, and the socket is so made that all wiring can be done from the outside. It is not necessary to take the socket, socket



A Fitting Which Excludes Moisture and Gases

holder, etc., apart when connecting—a feature which alone is a great time-saver. The glass is blown instead of cast, and will allow for a great temperature variation without cracking, as in a case where water or spray will strike the glass while heated by a lighted lamp.

This unit is particularly adapted to work where economy of space and ruggedness is called for. It is made in sizes for lamps from 25 to 200 watts, and can be furnished in all standard pipe connections. It is manufactured by the Denison Electrical Fittings Company, of New York, and is handled exclusively by Frank E. Watts, 30 Church street, New York City.

Shipping Hoisting Engines by the Trainload

The accompanying illustration will be of interest to our readers, as it shows what can be done by a concern when it has the proper enterprise and personnel to take hold of such business on a large scale.

A short time ago the announcement was made in these pages that H. D. Van Doorn, 516 Liberty building, Philadelphia, Pa., had accepted the management of the newly-organized marine department of the American Clay Machinery Company, of Bucyrus, Ohio. In conversation with Mr. Van Doorn a few days ago, he informed us that this photograph, reproduced herewith, shows fifty of the hoisting engines loaded on ten cars, which the American Clay Machinery Company are manufacturing for the Emergency Fleet Corporation and others, and for which they have orders running into the thousands.

This photograph was taken of a partial shipment to the American International Shipbuilding Corporation at Hog Island, Pa., and represents two shipments leaving their plant at Willoughby, Ohio, on two consecutive days, and we understand that they ship these machines in large quantities daily. These hoisting engines are being installed on vessels all over the country, not only at the yards controlled by the Emergency Fleet Corporation, but also at a great many of the privately-owned shipyards. They have 9-inch by 9-inch cylinders and single drum, and are single-geared and fitted with a reverse valve.

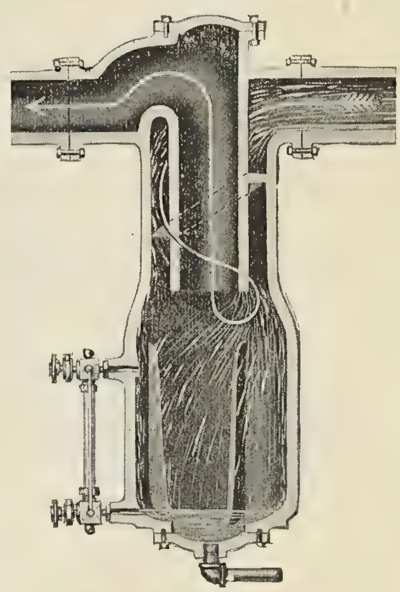
We understand that the American Clay Machinery Company are also manufacturing large quantities of windlasses, steering engines and capstans, and we hope to be able to illustrate them at an early date.

Meals to Be Wheatless on Lake Vessels

The wheat saving campaign was given a substantial boost by the recent announcement that all passenger steamship lines operating on the Great Lakes have decided to eliminate wheat from their menus until the next harvest.

Water Mechanically Removed from Compressed Air Lines by Stratton Air Separator

For the removal of water from compressed air, the Griscom-Russell Company, 90 West street, New York, N. Y., is manufacturing a new appliance known as the Stratton air separator. Water in compressed air is very detrimental to the



Section of Stratton Air Separator

proper operation of pneumatic tools, etc., and the Stratton air separator is designed to remove this water mechanically.

Centrifugal force is utilized as the means of separating the water from the air. As the water and air enter the separator they are caused to pass through a helical path formed about a central core. This helical path imparts a whirling motion to the air and water; and as water is several hundred times heavier than air, it is thrown out of the curving air current by centrifugal force. The water meets the wall at an angle without the slightest splashing action, and slips smoothly along, following close to

the wall until it reaches the receiver space at the bottom, at which point the swirling motion is checked by proper baffles.

The operation of the separator is purely mechanical, and it is, therefore, necessary that the air be of sufficiently low temperature to insure that all of the moisture is condensed. This is usually the case when properly cooled compressors are used or after coolers are employed.

Makes Push Switch Installations Steam-Tight

Double push button switches, because of their ease of operation, have always been popular, but their use has been restricted by reason of the liability of moisture, gas or dust getting into the operating parts. The Crouse-Hinds Company, New York, has designed and placed upon the market a cover with a switch-operating mechanism for use with these switches, when installed on condulets of either the FS or FD series,

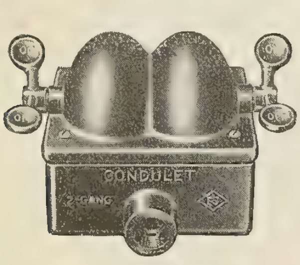


Fig. 1

which eliminates the objectionable features. This cover is made in one- and two-gang forms.

In Fig. 1 a two-gang cover is shown installed on a condulet, while Fig. 2 is of a single-gang condulet and cover, with cover unmounted. Like the condulet, the cover is a casting, either iron or brass, as specified. Iron covers are regularly finished in black enamel, although galvanized finish or any other plated finish

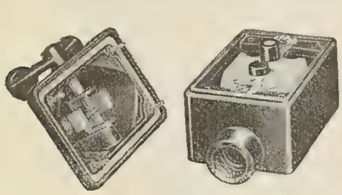


Fig. 2

will be furnished, if desired. Marine finish is standard for brass covers.

The mechanism which operates the push buttons is under the dome of the cover, and is controlled by a shaft, flattened at its inner end and extending through the side of the cover, where it terminates in the operating handle. That portion of the shaft which passes through the cover is provided with grooves containing hard grease, which effectually seals the bearing, and a rubber gasket likewise seals the joint between the cover and condulet. "On" and "Off" indicators, cast on the ends of the handle, facilitate the operation of the switch.

With this cover and the necessary condulet, it is now practical to use push switches in places where excessive moisture, explosive or corrosive vapors or fine dust circulate in the atmosphere, as in marine use, ammunition plants, refineries, textile and flour mills, and the numberless other locations which suggest themselves to the electrician.

Small Geared Turbines

To drive small electric lighting outfits, exciter units for large alternators, or for direct mechanical drive, there has been a demand for a line of steam turbines which would be constructed along the same lines which give durability, ease of adjustment and high economy to the larger turbine units. To meet this demand, which now comes principally from our new merchant marine for lighting sets, the Westinghouse Electric & Manufacturing Company has developed a line which is being manufactured in sizes from 15 to 50 kilowatts for direct-current service, from 30 to 50 kilowatts for alternating-current service, and from 30 to 100 horsepower for mechanical drive.

This machine is a geared unit, very compact and of rugged construction, as shown in the view of the direct-current unit, Fig. 1. The turbine operates at a speed of 7,200 revolutions per minute, and it is suitable for both condensing and non-condensing operation. It is built for normal operation on any steam pressure from 75 to 250 pounds, and for non-condensing operation on any back pressure up to 20 pounds. It embodies the three-point suspension principle, be-

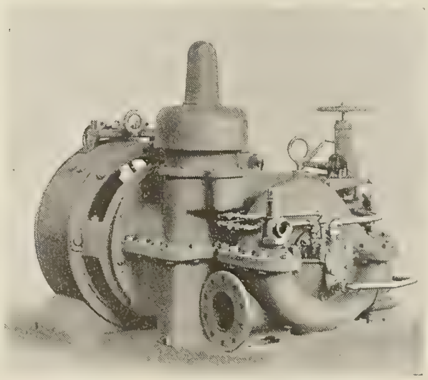


Fig. 1.—Direct Current Unit

ing supported by two lugs on the generator and one under the center of the turbine, thus maintaining, it is claimed, perfect alinement of the turbine, gear and generator.

The generator is of the well-known Westinghouse "SK" type, compound wound, with commutating poles. This design insures sparkless commutation even at heavy overloads without shifting the brushes—an important advantage, since no attention is required to adjust for changing loads. Coils are impregnated by the vacuum process, making them proof against even extreme dampness. The outboard generator bearing is supported by a single-piece bracket bolted to the frame. In this a steel shell lined with babbitt forms the bearing itself; it is pressed and pinned into place, and in case of trouble can readily be renewed by driving out with a heavy hammer. Oiling is by a ring running over the shaft and dipping into an oil well. The shaft may be pressed out of the armature without disturbing the connection between coils and commutator. Liberal spaces for ventilation are provided.

The internal construction of the turbine is practically identical with that of the larger machines. It consists of a single rotating wheel with blades or buckets around its periphery; the steam from the directing vanes or nozzles impinging against these blades causes the wheel to rotate and the work to be per-

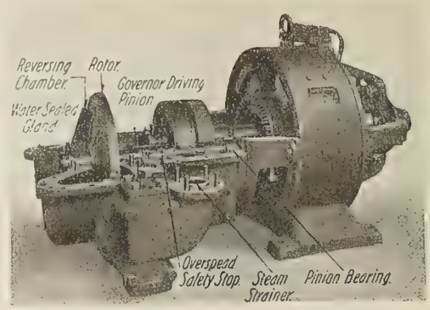


Fig. 2.—Geared Turbine Unit with Upper Casing Removed

formed. The full energy of the steam is extracted by using only one wheel with the aid of what is commonly known as the re-entry principle; that is, the steam, after passing through the blades the first time, is changed in direction by means of a reversing chamber and is directed against the blades a second time. The nozzle and reversing chamber are made of phosphor bronze, designed specially to resist the erosive action of steam at high velocities. In the 15- and 25-kilowatt units, the nozzle block contains but one nozzle, while in units of from 25 to 50 kilowatts capacity the block contains two nozzles, one of which is controlled by a hand-operated valve; at partial loads this valve may be closed, and thus the water rates are greatly decreased and a much higher efficiency is obtained.

Bearings on the turbine end of this machine are cast iron, lined with babbitt. Those on the rotor and pinion shaft are of the adjustable type; thus making it possible to keep a perfect alinement between pinion and gear at all times. The outboard generator bearing is a steel shell, lined with babbitt, pressed into the housing and pinned in place. It is ring-oiled. The pinion is milled out of the solid rotor shaft, thus entirely eliminating the coupling previously used to connect the pinion and rotor shafts.

These machines are fitted with standard water-sealed glands of brass, shrunk on the shaft. These glands seal the turbine casing around the shaft, and prevent steam from escaping when operating non-condensing, or they prevent air from entering when operating condensing. By using water glands in place of metallic or other similar glands, the friction loss is greatly reduced and wear is entirely eliminated, thus doing away with the replacing of parts at regular intervals, as is necessary with metallic glands.

It is a recognized fact that no governor is more reliable than the slow-speed governors used on Corliss engines. The governor on this unit is of the low-speed vertical fly-ball type, identical in construction with the governors on the larger units. This slow speed is ob-

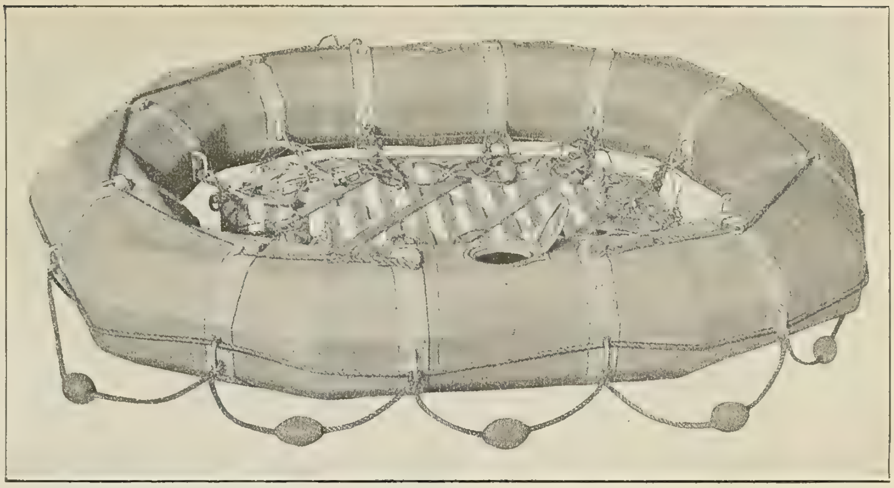
tained by driving the governor with a pinion on the slow-speed gear shaft. The fly-balls are pivoted on knife edges, and they are very sensitive to even slight speed variations in the turbine.

At the base of the governor, and driven by the governor spindle, is a gear oil pump, which furnishes the oil for both turbine and gear. The bottom of the gear housing is used as an oil reservoir, the pump lifting the oil from this reservoir to the top of the gear case, from where it flows by gravity through the oil strainer and to the bearings and other parts needing lubrication. The oil is kept cool by a copper cooling coil in the bottom of the oil reservoir, and through which cold water is kept continuously circulating.

One of the special features on this unit is the automatic throttle valve, operated directly from the governor by means of a connecting rod. This valve is of the balanced type and very sensitive in operation, thus insuring a close speed regulation.

One of the latest refinements provided on very few small turbines is the overspeed governor release. This is a simple device contained in a small hole drilled in the shaft between pinion and rotor. It consists of a cylindrical weight held in place by a coil spring surrounding it. In case the turbine should speed up to 10 percent above normal speed, the weight due to centrifugal force overcomes the spring tension and protrudes a short distance from its normal position. By so doing it comes in contact with a lug, which in turn is fastened to a lever, the movement of which trips the throttle valve catch and allows the valve to be closed by a heavy coil spring.

This line of turbo-generators conforms to the Navy Department's specifications for ship service, being provided in this case with both steam- and water-sealed glands and non-corrosive brass piping.



Cambridge Reversible Life Float

Cambridge Reversible Life Float

The Cambridge reversible life float, illustrated on this page, is elliptical in shape, the elliptical ring consisting of a copper tube with octagonal sides. The

(Photograph copyright by International Film Service, Inc., N. Y.)

Oil Tanker *Herbert L. Pratt* Ashore Off Delaware Capes After Attack by German Submarine. This Vessel Was Subsequently Floated and Towed to a Repair Yard

copper tube is subdivided into air- and water-tight compartments by copper bulkheads, spaced 18 inches apart inside the tube. All lengthwise and crosswise seams of the copper tube are ½-inch standing seams of five-ply thicknesses of copper, formed by folding, pressing and soldering the edges of the sheets of copper. The copper tube is treated with asphaltum, and strips of wood, preferably bass wood, are placed over the copper. The wood is painted with navy gray waterproof paint, and securely fastened by metallic bands. The wood is then covered with a heavy canvas, from two- to four-ply thickness; two-ply being used on straight lines and four-ply on all joints where there are curves or turns. The canvas is thoroughly shrunk against it. The use and method of applying the strips of bass wood against the shell of copper give excellent protection to the shell and add to the durability of the apparatus. On account of the octagonal shape of the copper tube, greater buoyancy is secured than would be possible with a tube of circular section for the same size float.

The whole float, in proportion to its buoyancy and the number of persons that it will accommodate, is lighter, it is claimed, than any other float of the same dimensions. As the tube is made of a non-corrosive metal, covered with the most durable buoyant material known, it is claimed that the whole float will last practically indefinitely. Capt. Eugene O'Donnell, former supervising inspector

(*Photograph copyright by Press Illustrating Service, Inc., N. Y.*)

Charles Knight, Winner of the International Prize for Riveting Record at Bethlehem Shipyard, Sparrows Point, Md., With Helpers and Yard and Government Officials

and treated with waterproof paint. Galvanized metallic bands with handles, as shown in the illustration, are then affixed. In the center of each side of the tube, on both the top and bottom, are openings, closed with air- and water-tight brass covers, giving access to compartments for water, food, stimulants, pyrotechnic lights, first-aid appliances, etc. The floor board is rigged with heavy tarred manila rope, and is so arranged that no matter how the float lands in the water it is always right-side up, as both sides of the float are exactly identical.

The elliptical shape of the float, it is claimed, enables the float to be easily propelled or towed through the water. There are no sharp or pointed corners of any kind, all edges being curved and especially constructed for rigidity and strength. The metal bands around the tube give added strength and reinforcement to the whole structure; and as each band is provided with a handle, the entire float can easily be picked up and moved about or thrown off from the deck. The position of the handles is a factor of great value, not only as a support for persons in the water outside the float, but also as a buffer or protection between the copper tube and any heavy object coming up of the Fifth United States District of the Steamboat Inspection Service, who inspected the float under Government tests, recommends the float as a practical life-saving and non-capsizable appliance, made of the best materials, and, in his opinion, practically indestructible.

The Cambridge reversible life float is manufactured by Cambridge Reversible Life Float, Inc., whose works are at Cambridge and office at 40 Court street, Boston, Mass.

PERSONAL

H. A. Everett, professor of marine engineering, post-graduate department, Naval Academy, Annapolis, Md., and editor of the Questions and Answers department of Marine Engineering, has resigned, to accept the position of naval architect for the McClintic-Marshall Company, New York, which is establishing a new shipyard for building fabricated steel vessels in Baltimore.

Albert Ed. Saunders has resigned as naval architect of the Sun Shipbuilding Company, Chester, Pa., to become technical assistant to the president of the G. M. Standifer Construction Corporation, Vancouver, Wash.

A. Westwater, formerly chief engineer of the G. M. Standifer Construction Corporation, Vancouver, Wash., has opened an office as consulting engineer and naval architect in the Central building, Seattle, Wash. Mr. Westwater will represent the General Ordnance Company, of Denver, Col., which has contracts to build thirty-eight reciprocating marine engines for vessels under construction for the United States Shipping Board.

Charles T. Burton, formerly assistant hull superintendent with the Standard Shipbuilding Corporation, New York, has been appointed hull superintendent of the Atlantic Corporation, Portsmouth, N. H.

Victor A. Hartley, formerly assistant foreman, boiler department, William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has been appointed superintendent of the Badenhausen Watertube Boiler Company's plant at Cornwells, Pa.

H. A. Hornor, consulting engineer in the marine electrical field, has been appointed head of the electric welding section of the educational and training department of the United States Shipping Board, with headquarters at 140 North Broad street, Philadelphia, Pa.

Hubert C. Verhey, chief draftsman of the technical department of the Emergency Fleet Corporation, has been appointed head of the marine Diesel engine department of the Fleet Corporation.

Edgar C. Rust, secretary of E. H. Rollins & Son, has been appointed executive assistant to Howard Coonley, vice-president of the Emergency Fleet Corporation.

Karl R. Kennison was recently transfered from the Bureau of Yards and Docks of the Navy Department to the Division of Shipyard Plants, Emergency Fleet Corporation, with headquarters in Philadelphia.

Edgar S. Closson, consulting engineer, Montclair, N. J., has been appointed resident engineer in charge of concrete shipbuilding for the United States Shipping Board Emergency Fleet Corporation at Mobile, Ala.

L. F. Harza, formerly chief engineer in charge of design and construction of the 20,000-horsepower Canadian hydroelectric developer at Sault Ste. Marie, Ontario, has been sent to Jacksonville, Fla., by the Emergency Fleet Corporation to take charge of a Government concrete shipyard.

E. Logan Hill, assistant general manager of the Erie Railroad, has been granted leave of absence to serve as secretary of the United States Shipping Board Commission on Port and Harbor Facilities.

Charles A. McCune has resigned his position as chief engineer of the Commercial Acetylene Company to become sales engineer with the Page Steel & Wire Company, 30 Church street, New York, where his efforts will be devoted to sales and service in connection with Armco welding rods.

OBITUARY

John A. Connolly, marine engineer and pioneer shipbuilder, died at his home in Brooklyn, N. Y., on June 2, aged 88. Mr. Connolly was the designer of many noted vessels of the last generation, among them the United States gunboats *Seneca* and *Chenango*, and the steamboats *Grand Republic, General Slocum* and *Columbia*.

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Ban on Foreign Circulation of Marine Engineering

On July 5 a general order regarding permits to carry plans and specifications of ships, shipyards, dry docks, and the like out of the United States was issued by Howard Coonley, vice-president, U. S. Shipping Board Emergency Fleet Corporation, as follows:

"Hereafter permits to carry out of the United States photographs, prints or other reproductions of plans or specifications of shipyards, ways, dry docks or ships or of their parts or equipment will not be granted or authorized by or in the name of the United States Shipping Board Emergency Fleet Corporation except to officials of or representatives of the United States.

"The Secretary of the Treasury has been requested to issue orders to the collectors of the various ports to confiscate any such plans or specifications found in the possession of persons leaving this ountry."

As every issue of Marine Engineering contains information of the kind which the above order prohibits sending out of the country, it is probable that future issues of the magazine will not reach our subscribers who reside outside of the United States. Steps have been taken to have this order so modified that the magazine can be sent to subscribers in the countries allied with us in the war against Germany, but at the time of going to press no action has been secured in this matter, and, until further notice, the publication of the above order will explain the non-delivery of copies of Marine Engineering to foreign subscribers.

"All Hail, American Shipbuilders!"

"No more defiant answer could be given to the enemy's challenge," said General Pershing, in cabling the congratulations and thanks of the army in France to American shipbuilders for their splendid achievement in launching on July 4 ninety-five vessels, aggregating 476,164 deadweight tons. General Pershing's cablegram was as follows:

"The launching of one hundred ships on the Fourth of July was the most inspiring news that has come to us. All ranks of the Army in France send their congratulations and heartfelt thanks to their patriotic brothers in the shipyards at home. No more defiant answer could be given to the enemy's challenge. With such backing we cannot fail to win. All hail, American shipbuilders!"

While a few years ago the possibility of such a record would have been looked upon as miraculous, nevertheless this performance was not in any sense a miracle. It was the result of hard work by an army of patriotic American workmen, loyal to the cause for which the nation is fighting and inspired by the determination to spare no efforts in making the world safe for democracy.

The vessels launched on July 4 included forty-two steel vessels of 278,464 deadweight tons and fifty-three wood vessels of 188,700 deadweight tons. At the Union Iron Works in San Francisco, four merchant ships and eight torpedo boat destroyers were launched and there were triple launchings at the Ecorse plant of the Great Lakes Engineering Works, the Newark Bay plant of the Submarine Boat Corporation, the L. H. Shattuck yard Newington, N. H., the Newport News Shipbuilding yard at Newport News, Va., and the Moore shipbuilding plant at San Francisco. Seventeen war vessels, including fourteen destroyers, were also launched on the same day.

In addition to the Fourth of July launchings, there were many other notable achievements recorded during the month. The United States destroyer *Ward,* which was launched eighty-four percent complete at the Mare Island Navy Yard, San Francisco, seventeen and one-half days after her keel was laid, was put into commission seventy days after the laying of the keel. The first of the *Eagle* boats, building at the Ford plant in Detroit, was launched on July 11, and the novel methods of construction which have been developed for building this class of vessels will make it possible hereafter to launch these vessels at the rate of one a day. At the Ecorse (Mich.) plant of the Great Lakes Engineering Works, a 3,500-ton steel vessel has been launched fourteen days after its keel was laid. These and similar records prove that the shipbuilding resources of the country will not be found wanting.

Naval Architects' Annual Meeting

According to an announcement recently issued by the secretary of the Society of Naval Architects and Marine Engineers, the annual meeting of the society this year will be held on November 14 and 15 in the Engineering Societies Building, New York City, with the annual banquet on the evening of the 15th at the Waldorf-Astoria Hotel. This will be the twenty-sixth annual meeting of the society, and, owing to the tremendous growth of the shipbuilding industry in this country and the importance of its bearing on the outcome of the war, the programme will be of particular significance. As the membership of the society comprises most of the men who are in charge of shipbuilding operations throughout the country, the meeting, if well attended, will give a splendid opportunity for the interchange of ideas and a comparison of methods for speeding up the production in the shipyards.

Papers have been promised dealing with the design and construction of concrete ships, wooden ships, structural steel standardized cargo vessels, unsinkable ships and experiments upon simplified forms of vessels. An opportunity for a thorough discussion of the new methods of shipbuilding, which have been introduced primarily as a war measure, will be given by the presentation of papers on the great assembling plant at Hog Island and the Ford

plant at Detroit. Other papers will deal with electric welding, geared turbines, notes on launching ways, side launchings, floating dry docks, shipyard tools, electric auxiliaries, hull vibration and similar topics. In addition to this, it should not be forgotten that this year junior members of the society will be expected to contribute papers for discussion. For the best paper from a junior member a prize of $100 (20/16/8) has been offered by H. L. Aldrich, member of council of the society and publisher of this journal.

Taken from every standpoint, the meeting will be a notable one, as it will reflect what American naval architects and shipbuilders are accomplishing in the most momentous period of their history.

University Training in Merchant Marine Administration and Operation

In order to meet the demand for a body of trained men to supply the organization for the direction of the growing American merchant marine and to prepare for competition after the war, a course in the principles of merchant marine administration and operation will be included in the curriculum of the New York University next fall. The course will be given two nights a week at the Wall Street division of the university by William H. Brittain, secretary of the American Steamship Association. A similar course, it is understood, will also be given at the College of the City of New York.

While shipping men look upon practical experience as an essential in rounding out any course of training for the merchant marine, nevertheless it is universally agreed that much can be done through teaching at the universities. The element of time requires that action should be taken immediately, so that at the end of the war the United States will not be caught unprepared. The course at New York University will cover a wide range and include such topics as marine underwriting, ship and freight brokerage, Admiralty law, international law affecting shipping and ship operation, rates and rate structure, government relation to shipping, etc. Judging from the results obtained from the course in marine insurance, which was inaugurated at New York University last year, for which there were four hundred applicants, the new course will attract an even larger number of students and furnish a most valuable aid in building up the American merchant marine.

Industrial Housing Construction

In his introduction to the report recently made to the American Concrete Institute by its committee on Industrial Concrete Houses, the chairman, Mr. Leslie H. Allen, of the Aberthaw Construction Company, of Boston, alluded particularly to the relation of labor turnover to the suitability and adequacy of the housing.

The housing programme of the Government entrusted to the Shipping Board and the Department of Labor will set the standard of housing for many years to come. It is of the utmost importance that these standards should be higher than the low standards that now prevail and especially that the work done be of such permanent character that it may prove to be an adequate security for the expended funds and for long-term mortgage bonds at low rates of interest.

The concrete house is now an accomplished fact. It has come to stay. For many years experiments have been made with many types, many of the earlier houses were quite unsuitable and showed defects, but the later examples are much improved, the earlier defects are being eliminated and the concrete house, as built to-day, is a thoroughly sanitary, weatherproof, permanent and fireproof home. It approaches more nearly the ideal home than any other type of construction.

Good and sufficient housing is one of the most pressing needs of the nation at this time. Without it we are seriously handicapped in winning the war. The provision of good housing is not only an immediate need but a permanent national gain, and every one who lends his influence and aid to the securing of this end is rendering a real service to the nation.

The Alien Enemy Act

In order that there may be no misunderstanding regarding the purposes of the Alien Enemy Act, Mr. A. Mitchel Palmer, custodian of alien enemy property, has issued, through the Editorial Conference of the New York Business Publishers' Association, Inc., a statement outlining the scope of this Act and the duties of the custodian of alien enemy property. As this Act has a direct bearing on the marine as well as other industries, we direct special attention to Mr. Palmer's statement, which follows:

There are two ways of making war against an enemy. One by force of arms; the other by force of economic pressure.

When a nation wages economic war it brings to bear upon the enemy every force it can muster to stop his supply of food, money and munitions and thereby make him weak and impoverished.

The day the United States entered the war there was in this country millions upon millions of dollars belonging to Germans. It was invested in mines, factories, banks, steamships, farms, plantations, etc., etc. Its total amount might run into billions. We had no way of estimating them. But we did know that it was German gold that was colonizing industries here in America and that it was good American money that was being shipped back to Berlin in the form of earnings to enrich the German nation, to fill its war chests, to help complete its great plan for a world control of commerce and industry.

When war was declared, the Army and Navy started to mobilize men and guns, the Shipping Board to build the fleet: the War Trade Board to cut all commercial relations with the enemy, and the Alien Property Custodian to gather into the Treasury of the United States every penny of German-owned money that could be found. That is why the office of the Alien Property Custodian was created.

The duties of the Alien Property Custodian are exactly what the name implies, only, in addition to the work of taking over and administering holdings of enemies, he has been given power by Congress to sell outright those properties belonging to the great industrial and corporation classes of Germany planted here in America.

In order to help it is important to know just *who* is an "enemy" and *what* is "enemy" property.

Enemy property includes any and every kind of property, money, chattels, securities, lands, indebtedness, accounts receivable, etc., which belongs to an enemy. Even if the property is held in the name of another—by a dummy or in trust—if the real beneficial interest belongs to an enemy, it is enemy property.

An enemy under the Act is:

1. Any person, regardless of citizenship or place of birth, which is within the boundaries of Germany, Austria-Hungary, or their allies, or within the territory actually occupied by their military or naval forces. A peaceful and law-abiding German or Austrian citizen residing in the United States is not an enemy; but an American citizen living in enemy territory is an enemy.

2. A person residing outside of the United States and doing business within the territory of enemy countries or their allies.

3. A corporation, if incorporated within the territory of enemies or their allies, or incorporated in any neutral country and doing business within the territory of enemies or their allies.

4. An official or agent of an enemy Government or any subdivision thereof.

5. All natives, citizens, or subjects of Germany or Austria-Hungary interned by the War Department.

6. All citizens or subjects of Germany or Austria-Hungary resident outside of the United States who are (a) wives of officers, officials or agents of Germany or Austria-Hungary, wherever resident; (b) wives of persons within the territory (including that occupied by military and naval forces) of Germany or Austria-Hungary; or (c) wives of persons resident outside the United States and doing business within enemy territory.

7. Citizens or subjects of Germany or Austria-Hungary who are prisoners of war or who have been or shall be interned by any nation associated with the United States in the war.

8. Citizens or subjects of Germany or Austria-Hungary who since April 6, 1917, have disseminated or shall hereafter disseminate propaganda to aid any enemy nation or to injure the cause of the United States, or who have assisted, or who shall assist in plotting against the United States or any nation associated with the United States in the war.

9. Citizens or subjects of Germany or Austria-Hungary who are included or who shall be included in the "Enemy Trading List" published by the War Trade Board.

10. Citizens or subjects of Germany or Austria-Hungary who, at any time since August 4, 1914, have been resident within enemy territory.

Note: Numbers 2, 6, 8, 9 and 10 apply only to persons resident outside of the United States.

Three-quarters of a billion dollars' worth of property have been reported to the Alien Property Custodian at Washington to-day, but from our investigation throughout the country we know that there is much more not yet located. Here is where the citizens can render valuable assistance.

You can help the nation by mailing the Bureau of Investigation, Alien Property Custodian, Washington, D. C., reports or information on enemy-owned property in your vicinity. You are shareholders in this great combination trust company, department store, and auction sale, now run by the government, and the larger you swell its holdings the more you will back up the Army and Navy now battling against the Hun.

American Classification for American Ships

The article entitled "American Classification for American Ships," by Winthrop L. Marvin, published in the April issue of Marine Engineering, pages 206 to 210, has brought out a great deal of violent criticism, particularly on the part of certain English publications. Apparently the writers of these criticisms speak from the standpoint of prejudice rather than of actual knowledge.

Mr. Marvin's article was gracefully written and intended to be a club stuffed with straw. If spikes had been put in the club, the article would have stated the case somewhat as follows:

Before the American Bureau of Shipping was organized under its present officials, American shipping interests are alleged to have practically offered to turn over the classing of American vessels to a British organization with the distinct understanding that plans and specifications should be passed upon in this country instead of sending them across the ocean and waiting weeks and oftentimes months for them to be passed upon. Experience had shown that even when plans have been passed upon, decisions have been revoked by cable, thus seriously interfering with the construction of the vessels in this country.

American shipping interests apparently offered to meet the British interests more than half way, but, instead of the offer being received in the spirit in which it was made, complete and abject surrender was demanded, putting entire control of the designing of American vessels into certain hands in London.

This did not appeal to the American shipping interests, and, as a consequence, the American Bureau of Shipping was brought up to the splendid basis upon which it rests to-day. The question of standing by our ally has nothing whatever to do with the classing of vessels. The only point at issue was whether or not American shipping interests were willing to submit to complete and abject surrender to a British demand or stand on their own rights and design their ships as best suited American needs.

LETTER TO THE EDITOR

An American Prerogative

No recent decision of the United States Shipping Board has been more gratifying to American shipowners and builders than the frank preference given in Washington to the American Bureau of Shipping in the survey and classification of merchant ships contracted for this year by the government. This is in logical harmony with the general policy of the Board as now constituted, to develop our new merchant marine on foundations that are distinctively American and permanent.

As was anticipated, there has been an effort on the part of injudicious friends of the British Lloyd's Register to twist this wholly natural preference for the American society into an unfriendly act toward an ally, but this is camouflage by which no open-eyed man can be deceived. The most important work which the British Lloyd's surveyors came here for was in connection with certain craft ordered some time ago, before we entered the war, by British and Scandinavian concerns, backed quite possibly by the British government. But since these ships have been taken over by our own government, there is no further need of or pretext for the employment of a very thoroughgoing British institution for the survey and classification of ships built for and owned by the American nation—a service for which a competent and strengthening American society is already in existence.

Incidentally, it may be said, in a spirit of friendly admonition, that the British Lloyd's Registry has scarcely commended itself to further American favor by the bitter personal attacks in certain British maritime journals on those American citizens who have advocated the policy of preference for American interests. Nor would it prove very advantageous if an American classification society in a similar case were to maintain in London a lobbyist at a salary higher than was paid to its trained engineers.

To choose the American Bureau of Shipping for the vital work of surveying and classifying the new American merchant steamers is the natural exercise of an act of national sovereignty, any external interference with or external criticism of which is most certain to arouse vigorous resentment.

Boston, Mass. Winthrop L. Marvin.

Schwab's Fourth of July Address to the Shipyard Workers in San Francisco

Director-General of the Emergency Fleet Corporation Urges the Men to Speed Up Shipbuilding—Recognition Promised for Production Records

SOME of the finest records, perhaps the very finest, of shipbuilding achievements made since we entered this war, have been scored on the Pacific Coast. Every man in every shipyard in America is performing a very necessary and very patriotic service. It will go farther, perhaps, toward winning the war than any other service short of the fighting on the battlefields of France. Building ships is the first job that must be done if we are to overcome the menace of the submarine. In building these ships and in building them as well and fast as they can be built you are answering the call of America.

Fourth of July Launchings Greatest in History of the World

While the returns from the shipyards are not yet in, I venture to predict that the number of ships launched on July 4 is the greatest record of launchings for a single day in the history of the world. When the truth percolates to the German people they will know that their leaders have deceived them; that Americans have their sleeves rolled up and we have our fighting blood up; that we are going to win this war if it takes the last man, the last ounce of strength, the last resource and the last dollar that this country possesses.

All shipbuilders have dedicated their service to America. At last we in this country have come to realize our true position, and we stand firm, determined and unafraid before the naked truth that we must defeat Germany or Germany will defeat us. We have to go over the top in the shipyards just as the United States Marines went over the top at Chateau Thierry in France. That is the kind of fighting spirit that is making our shipbuilding a success. I find it everywhere in the shipyards.

Germany Feels the Blow

Wars are not won altogether on the battlefield. News of America's accomplishments in the shipyards causes almost as much consternation in Germany as actual defeat. Do not think for one minute that the Prussian generals are unmoved by what we are accomplishing. They know that we launched a 5500-ton ship in 27 days from the time the keel was laid over in Camden, N. J. That was a tremendous accomplishment never before approached in any country and it was a blow in the face of Prussian confidence. Our enemy knows, too, that it is the workmen over here who are making these things possible; that the men in the shipyards are working day and night, determined, untiring and enthusiastic; that they are backing up the boys in the trenches. The Kaiser knows that with the united backing of American workmen, American armies can never be beaten. The credit for winning this war will be shared equally by the workmen of America and the fighters of America.

It was in the West that speed records were first made in the shipyards. Before the war began it took from six months to a year to build the largest types of steel ships, but the Pacific Coast cut down this time to 90 days and then to 55 days. It is men like Dave Rodgers, at the Skinner & Eddy plant, and Joe Tynan at the Union Iron Works—men who know their jobs and treat their men squarely—on whom the Government relies for the right leadership in this shipbuilding programme.

Rivet Heater Boy a Young Hero

The best captains and colonels in our shipbuilding army, however, cannot build ships without the strong armies of the privates, corporals and sergeants. The heater boy to-day is a young hero who deserves a place alongside the drummer boy in that picture seen so often—"The Spirit of '76."

I had a telegram recently telling me how Burt Myers, a riveter and his gang in the Long Beach Shipbuilding Company's yard, drove 2,137 seven-eighth-inch flush rivets in a shell in eight hours. That kind of a day's work, made by steady workmen and translated into high averages, puts ships into the water in record-breaking time.

It is the high average, of course, that is the best gage of shipbuilding temperature. It is the worker who stays on the job even at the cost of pride and personal sacrifice that counts for America and against Germany. The man who forgets his own troubles, who thinks only of his country, is the kind of man who is needed in American shipyards to-day

Army of 300,000 Shipyard Workers

We have a great army of workers building ships for this emergency. There are 300,000 of us, and we are all fighting for America. You men who swing the cranes are in charge of the big guns. You who drive the rivets are operating the machine guns of the shipyard. Every man who does a full day's work is doing his share to win the war. The gangs at work on a ship are holding a trench and when they launch that ship they go over the top. When they lay a new keel they are digging in and making ready for another long defense.

German submarines appeared recently off the Atlantic Coast, trying to crowd us off the ocean highways. That was no new thing for Germany. Prussian officers in German cities crowd civilians off the pavements when they stride through the streets. Americans are not the oppressed tired people the Germans are. Americans know their rights and will fight for them. They wont be crowded off the streets or off the ocean highways. Germany's purpose in sending submarines to American waters was to cow this great nation into inaction and to paralyze our preparations. Germany has failed in her purpose. The loss of a few ships may sting but it only goads us on to harder fighting.

Fruitlessness of German Submarine Raid

Every time we launch a cargo or troop ship or tanker we add to the certainty that German submarines cannot win this war. Already we have the U-boats on the run, and if we keep up the pace we will have them beaten by next year. And when we achieve this victory it will be you who will deserve the credit. So far as I am concerned, and so far as Mr. Hurely is concerned, and I am sure so far as the President of the United States is concerned, you will get the credit.

Now what did this German raid on American shipping

really amount to? These scavengers of the sea began their activities on May 25 and we continued to hear from them up to June 15. In that time they had sunk 10 American vessels of 26,000 deadweight tons. These were mostly small ships, unarmed and of no great consequence in the winning of the war. In the same period of time, from May 25 to June 15, American shipyards completed and delivered to the United States Shipping Board 30 vessels, ranging from 3,500 to 10,500 deadweight, and aggregating 167,000 deadweight tons. Place 30 ships of 167,000 tons against 10 ships of 26,000 tons and you can see how much this terrible submarine raid amounted to.

These figures are correct. It will take more than an occasional submarine raid off our coasts to make the American shipbuilder throw up his hands and cry, "Kamerad!"

Germany's only hope now, if it can be called a hope, is to win this war by great military victories. Germany knows that we are building ships and getting a real army across the Atlantic. The Kaiser is making his supreme effort now in the knowledge that America will soon be started and will stay in the war until it is won. If we complete our shipbuilding programme they will know over in Germany that not a shred of hope remains. Can we complete it? Can we build these ships in time to keep our bridge to France unbroken? That is a question for you men in the shipyards to answer. America has never lost a war and she is not going to lose this one.

Building Ships Faster than Submarine Can Destroy Them

To-day we are building ships faster than the submarine can destroy them. Meanwhile, our Navy is destroying submarines. The German hordes may make some advances on the Western front, but are we downhearted? No. Our army in France and our shipbuilding army at home are getting into their full stride and we will whip them if it takes everything we have.

We must get the men and the guns and the airships over. More and more men must go over, and more guns and rifles and motor trucks—rails, clothing, and horses—but the whole job depends upon you. I, for one, have every confidence that you will do the job and do it right.

There is a glory in this war that will belong to you and you alone. I know that when you are working in the shipyards, wet with heat, tired, you have in your minds a picture of a ship completed—strong, durable, powerful. You can picture also the stevedores loading that vessel in an American port, American soldiers going aboard, a sharp, swift encounter with a submarine, the safe arrival at a war port on the other side, and the joy of Pershing and his men. With every arrival of new troops or more food, ammunition, guns and clothing you put heart into the boys in the trenches. That is a privilege and a glory that belongs to you and can belong to no one but the shipbuilders of America.

Vast Growth of American Shipbuilding

Now you wonder, naturally, how your work has counted. Let me tell you. In 1915 all the shipyards in America turned out 215,602 deadweight tons of shipping. The next year when the demand for ships in foreign countries became so great that every existing yard in America entered into keen competition for foreign contracts, our output jumped to 520,847 tons, or almost double the total for 1915. In 1917 the hot pace continued until we very nearly doubled the output of the previous year, completing a total of 901,223. We thought we were building ships, with almost a million deadweight tons of finished vessels, but I am confident now that if we pull together and every man stays on the job, we will produce more than 3,000,000 deadweight tons in 1918—the greatest output of any nation in the world in a single year.

It is a record of which any industry and any nation may well be proud. Last year I would not have said it was possible to do much more in 1918 than double last year's output because we had done fairly well, considering our facilities, when we produced 901,223 tons in 1917; but I am convinced now that the spirit that actuates the men in the yards, with the enthusiasm that lightens our task and with the determination to win out that is a part of every true American to-day, we will have more than trebled the output of last year when we get through with 1918.

Our shipbuilding programme is coming along. We are now just getting into our stride. I think that we can point with some pride to May of this year, when we not merely launched but completed 263,000 tons of shipping —more than was turned out in the entire year of 1915. This has been made possible by the enlistment of the whole-hearted support of every industry engaged in any part of the shipbuilding job. If we can build 263,000 tons of ships in one month when some of our yards are not yet completed and when we are still training men to build ships, think of the vast possibilities in the years to come. We Americans must replace the shipping that the war has taken. It is a stupendous task. Five years ago, if you had been told that this country would produce 263,000 tons of shipping in a single month, you would not have believed it, but that is a mere beginning of the task that lies before you men in the shipyards.

Marvelous Shipyard at Hog Island

You have heard something about the big Hog Island Shipbuilding plant outside of Philadelphia. That plant has 50 ways. It is a world's fair in itself and nothing like it has ever been dreamed of in the shipbuilding industry. It has acres and acres of shops, miles upon miles of railroad lines. It is the working place of 35,000 toilers. Hog Island presented a problem that could only be solved by Herculean effort, and this required courage. It was an undertaking that no nation in the world except America would have ventured upon, but we are going to put it through.

They have been delayed down at Hog Island in getting their fabricated steel, but we are not going to have that trouble in the future, because we have made arrangements for the construction of two big fabricating steel plants to add to the output of 67 plants already engaged in fabricating work. More than half the ways of Hog Island now are occupied by hulls. Before long they will begin shoving these ships into the water and Admiral Bowles, who has charge of this work, tells me when Hog Island gets into full swing there will be a launching there every other day.

The shipbuilders on the Great Lakes will produce between 400,000 and 500,000 tons this year, and they are preparing to double their output next year. A fine spirit of co-operation is in evidence in the yards along the Lakes and I have every reason to believe that they will carry a full share of the burden.

I have to make good in this job. I never had a more important job or a more serious one. I want to make good but I can't do it unless you can make good in your job. I am an optimist by nature. I always feel that our goal should be set a little higher than what we expect to accomplish and then if we strive to reach the goal with

all our energy and enthusiasm, why we will reach the goal and pass it.

I want to give you some of the enthusiasm that I feel about this shipbuilding enterprise. I believe it cannot fail and if I can make you believe that and work at your job with the same energy that I expect to put into my job then I know it cannot fail.

There is one thing that we need if we hope to reach our maximum capacity of production and that is a friendly rivalry between the yards. I have tried to encourage that because I know that competition is dear to American hearts and I know that you will respond to a challenge.

Government Recognition for Exceptional Services

Now we are going to recognize a shipyard that surpasses all others in actual production each month. A blue flag which this yard will be authorized to fly on its flagstaff will be a mark of national recognition. It will be in the shipbuilding field what an award for distinguished service is on a battlefield.

There is a board at Washington composed of men who know the science of shipbuilding, headed by Rear Admiral Fletcher, which will determine the winners in this great national contest between shipyards. This board will consider every factor in the progress of the various yards not only in awarding the blue flag for first place but also the white and red flags which are to be presented for second and third place. Any yard which holds first place for three consecutive months will have signal honors, for it will be authorized to fly this championship blue pennant permanently from its flagstaff.

Service Badges for Shipyard Workers

Now there are many men in the shipyards who feel a sense of embarrassment because, with their country at war and Liberty in danger, they are not in the uniform of the Army or the Navy. I want to say that these men, if they are shipbuilders, and belong in the yards, are entitled to just as much recognition and just as much honor as the brave boys on the sea or in the trenches. And it is to give you shipyard workers such recognition that the Government has determined upon the awarding of service badges to the men who give four months' faithful service to the Government in the shipyards at building ships, and bars for additional length of service. With these service badges you can walk through the crowds, meet the boys of the Navy and the Army and hold your heads high. To sacrifice one's life for one's country is, of course, the supreme sacrifice, but in this war the highest duty is to serve where your Government tells you to serve.

We are going to give special gold and silver medals for unusual service in the shipyards. We feel that there should be some way of recognizing the man who does a great thing for his country in war time. Great things are being done to-day in the shipyards. Every one of you has a chance to win honors in this great fight in the American shipyards against the submarines—a battle of construction against destruction.

The Government appreciates what you men, and the men in other yards on the Pacific Coast, are achieving in the great struggle of America to maintain the independence that was won so many years ago. Because of my long association with you, I feel that I can ask you, perhaps more freely than I can ask others, to put every ounce of your strength and energy into the task of building ships for America. There is nothing that I will not sacrifice to help in winning this war, and I know that there is nothing you will not sacrifice. Put punch in your work and we'll put over the programme. If you stand up to your job, we'll make the Kaiser take his medicine lying down.

Barge Model Built of Concrete to Test New Type of Construction

A navigable barge model has been built of concrete by the Newton Engineering Company, Milwaukee, Wis., according to designs by George C. Newton, vice-president of the company. It has a length of sixteen feet, beam of forty inches, and molded depth of twenty inches. The concrete skin is only three-quarters inch thick, being supported at intervals by fabricated concrete frames. The vessel has a draft light of seven and one-half inches and a total displacement of about two tons.

In its construction a concrete keelson and keel, together with one row of longitudinal girders midway between the keelson and bilge, were cast integral with the skin. The concrete deck extends for three feet at the bow and two feet at the stern, together with a short section in connection with a concrete bulkhead amidships. The lines of the model are those of a cargo-carrying barge for canal use.

This boat was built primarily to test out certain construction methods and features of design involved in the Newton system of concrete ship construction. Among the objects sought were the securing of a comparatively thin concrete skin, a special design of reinforcement for all torsional, reverse, and longitudinal stresses, as well as those due to the direct water and cargo pressures. The Newton system also aims primarily to secure a practical method of concrete ship construction following the existing system for fabricating steel ships, and one which will permit the use of forms for a number of times for standardized ship sections. Incidentally it is claimed that great speed can be secured with this method of ship construction, due to the use of many parts fabricated in advance.

An interesting feature of the construction of this boat was that all the methods used in its building were exactly those that will be used for large ships. No difficulty was encountered in securing very good results in pouring the three-quarter inch thickness of concrete between forms for the skin.

For testing it out under power a three and one-half horsepower Evinrude row-boat motor is used. With this motor a speed of from four to five miles per hour is secured, with practically no vibration.

Norway's Merchant Marine in March, 1918

The statistics published by the Norwegian Department of Trade and Commerce concerning the Norwegian merchant marine in March, 1918, show that the net result for the month was a decrease of five vessels, with a total of 33,626 tons. On March 1, 1918, there were in the Norwegian merchant marine 3,260 vessels of 1,998,174 tons. During the month there were 34 vessels of 46,906 tons removed from the list of vessels, and 29 vessels of 13,280 tons were added, the net result being as stated above. On April 1, 1918, there were 3,255 vessels of 1,964,548 tons in the Norwegian merchant marine.

Of the ships removed from the list, 19, with a tonnage of 34,994 tons, were lost through operations of war. Of the vessels added to the list, 8 of 7,940 tons were built in Norway, this in addition to 17 motor boats of 1,400 tons. Four motor vessels were purchased abroad.

Ships Under Construction in the United States Total Nearly 14,000,000 Tons

Reports from Emergency Fleet Corporation Show 157 Shipyards with 834 Ways Have Under Contract 1,977 Ships of 13,718,850 Deadweight Tons

According to recent reports from the Emergency Fleet Corporation there are now in operation in the United States 157 shipyards, containing 834 ways. The total number of vessels under contract is 1,977, aggregating 13,718,850 deadweight tons.

The following list of shipyards, together with the number of shipways in each, the ships under contract and the deadweight tonnage, is reprinted, without verification, from the *Journal of Commerce and Commercial Bulletin* of New York City of July 11:

DISTRICT No. 1—NEW ENGLAND STATES

Shipbuilding and Yard Location	Ship-ways	Ships Under Contract	D.W. Tons
Wooden Vessels			
Portland Ship Ceiling Co., Portland, Me.	3	6	3,500
*G. A. Gilchrist, Thomaston, Me.	1	1	3,500
Cumberland Shipbuilding Co., Portland, Me.	4	9	3,500
L. H. Shattuck, Inc., Portsmouth, N. H.	12	18	3,500
Freeport Shipbuilding Co., South Freeport, Me.	2	4	3,500
*The Kelley Spear Co., Bath, Me.	3	1	3,500
Sandy Point Shipbldg. Corp'n, Sandy Point, Me.	2	2	3,500
*Crowninshield Shipbuilding Corp'n, South Somerset, Mass.	8	6	Tugs
Steel Vessels			
Groton Iron Works, Groton, Conn.	6	6	8,800
		6	9,400
Atlantic Corporation, Portsmouth, N. H.	5	10	8,800
*Bethlehem Shipbuilding Corp'n, Ltd., (Fore River Shipbuilding Corp'n), Quincy, Mass.	†18	3	9,100
		6	9,400
*Texas Shipbuilding Co., Bath, Me.	‡7	13	9,250

† Four building for U. S. Navy. ‡ Three building for private parties.

DISTRICT No. 2—NEW YORK AND EASTERN NEW JERSEY

Shipbuilding and Yard Location	Ship-ways	Ships Under Contract	D.W. Tons
Wooden Vessels			
The Foundation Co., Passaic River, Newark	5	10	3,500
*Groton Iron Works, Noank, Conn.	6	12	3,500
Ship Const. & Trading Co., Stonington, Conn.	2	2	3,500
Traylor Shipbldg. Corp., Cornwells Heights, Pa.	10	10	3,500
*Gildersleeve Ship Construction Co., Gildersleeve, Conn.	2	2	3,500
Kingston Shipbldg. Co., Rondout Creek, Kings.	3	4	3,500
*Johnson Shipyard Corp., Mariners Harbor, N.Y.	3	3	3,500
Housatonic Shipbldg. Co., Inc., Stratford, Conn.	6	6	3,500
Steel Vessels			
Downey Shipbuilding Corp'n, Milliken, Richmond Borough, N. Y.	4	10	7,500
Newburgh Shipyards, Inc., Newburgh, N. Y.	4	10	9,000
Federal Shipbldg. Co., Hackensack River, N. J.	10	30	9,600
		4	5,000
Bayles Shipyard, Inc., Pt. Jefferson, L.I., N.Y.	2	2	Tugs
*Bethlehem Shipbuilding Corp'n, Ltd., (S. L. Moore Plant), Elizabeth, N. J.	5	20	Tugs
		3	3,930
*Standard Shipbldg. Co., Shooters Island, N. Y.	†6	10	7,433
		13	7,300
*Staten Island Shipbuilding Co., Port Richmond, N. Y.	‡4	5	3,500
*Providence Eng. Corp'n, City Island, N. Y.		10	Tugs
Submarine Boat Corp'n, Newark, N. J.	28	150	5,000

† One for private owners. ‡ Two for private owners.

DISTRICT No. 3—CHESAPEAKE BAY

Shipbuilding and Yard Location	Ship-ways	Ships Under Contract	D.W. Tons
Wooden Vessels			
Maryland Shipbuilding Co., Sollers Point, Md.	4	6	3,500
Newcomb Lifeboat Co., Hampton, Va.	4	4	3,500
Henry Smith & Sons Co., Baltimore, Md.	4	8	3,500
Potomac Shipbuilding Co., Quantico, Va.	4	7	3,500
York River Shipbuilding Corp'n, West Point, Va.	4	8	3,500
*M. M. Davis & Son, Inc., Solomons, Md.		8	Tugs
Steel Vessels			
*Baltimore D.D. & Shipbldg. Co., Baltimore, Md.	4	7	Mine Sweepers
		8	8,800
		12	10,300
		6	6,000
	†4	8	6,240
Virginia Shipbuilding Corp'n, Alexandria, Va.	4	12	9,400
*Virginia Shipbuilding Corp'n, Wilmington, Del.		6	7,500
*Harlan & Hollingsworth	5	12	5,850
*Bethlehem Shipb'g Corp'n, Sparrows Point, Md.	7	9	12,000
		4	7,400
		14	9,650

DISTRICT No. 3—CHESAPEAKE BAY (*Continued*)

Shipbuilding and Yard Location	Ship-ways	Ships Under Contract	D.W. Tons
*Newport News Shipbuilding & D. D. Co., Newport News, Va.	‡11	9	9,770
*Pusey & Jones, Wilmington, Del.	4	14	4,200

† Two for navy. ‡ Five for navy.

DISTRICT No. 4—FLORIDA AND GEORGIA

Shipbuilding and Yard Location	Ship-ways	Ships Under Contract	D.W. Tons
Wooden Vessels			
*Hillyer-Sperry-Dunn Co. (operated by U. S. Shipping Board, Emergency Fleet Corp'n), Jacksonville, Fla.	†7	4	3,500
American Shipbuilding Co., Brunswick, Ga.	6	4	3,500
Tampa Dock Co., Tampa, Fla.	4	4	3,500
		4	3,500
J. M. Murdock, Jacksonville, Fla.	2	2	3,500
U. S. Maritime Corp'n, Brunswick, Ga.	4	6	3,500
North Carolina Shipbuilding Co., Morehead City, N. C.	2	2	3,500
Morey & Thomas, St. Johns, Jacksonville, Fla.	4	4	3,500
National Shipbldg. & D. D. Co., Savannah, Ga.	2	2	3,500
*Southland Steamship Co., Savannah, Ga.		7	Tugs
Steel Vessels			
Merrill-Stevens Shipbldg. Corp., Jacksonville, Fla.	4	4	3,500
		4	6,000
		6	9,000
		1	6,000
Terry Shipbuilding Corp'n, Savannah, Ga.	8	10	3,500
		10	7,500
Oscar Daniels Co. (Tampa S. B. & Eng. Co.), Tampa, Fla.	7	10	9,500
		2	3,500

† Two for private owners.

DISTRICT No. 5—GULF PORTS, EXCEPT TEXAS

Shipbuilding and Yard Location	Ship-ways	Ships Under Contract	D.W. Tons
Wooden Vessels			
*Merrill-Stevens Shipbldg. Corp'n, Slidell, La.	4	18	3,500
Dierks-Blodgett Shipbldg. Co., Pascagoula, Miss.	4	6	3,500
The Mobile Shipbuilding Co., Mobile, Miss.	6	18	3,500
Murnan Shipbuilding Corp'n, Pinto Point, Ala.	2	4	3,500
Hodge Ship Co., Inc., Moss Point, Miss.	4	4	3,500
Dantzler Shipbldg. & D.D. Co., Moss Point, Miss.	4	6	3,500
Jahncke Shipbuilding Co., Inc., Madisonville, La.	4	6	3,500
Steel Vessels			
Jahncke Shipbldg. & D.D. Co., Madisonville, La.	3	12	5,000
Alabama D.D. & Shipbldg. Co., Pinto Island, Ala.	1	2	7,500
Alabama D. D. & Shipbldg. Co., Mobile, Ala.	2	2	3,500
Pensacola Shipbuilding Co., Pensacola, Fla.	5	10	9,000
Johnson Iron Works, Ltd., New Orleans, La.		6	Tugs

DISTRICT No. 6—TEXAS

Shipbuilding and Yard Location	Ship-ways	Ships Under Contract	D.W. Tons
Wooden Vessels			
Universal Shipbuilding Co., Houston Ship Canal, Tex.	8	12	3,500
McBride & Law, Naches River, Beaumont, Tex.	2	4	3,500
Union Bridge & Const. Co., Morgan City, La.	6	6	3,500
National Shipbuilding Co., Orange, Tex.	†8	12	4,700
Lone Star Shipbuilding Co., Beaumont, Tex.	4	8	3,500
J. N. McCammon, Beaumont, Tex.	2	2	3,500
Southern D. D. & Shipbldg. Co., Orange, Tex.	5	5	3,500
Midland Bridge Co., Ship Channel, Houston, Tex.	6	6	3,500
Beaumont Shipbldg. & D.D. Co., Beaumont, Tex.	‡8	4	3,500
Heldenfels Bros., Rockport, Tex.	4	4	3,500

† One for private owner. ‡ Four for private owners.

DISTRICT No. 7—CALIFORNIA

Shipbuilding and Yard Location	Ship-ways	Ships Under Contract	D.W. Tons
Wooden Vessels			
*Hammond Lumber Co., Humboldt Bay, Cal.	4	4	3,500
Kruse & Banks Shipbldg. Co., North Bend, Ore.	5	6	3,500
Fulton Shipbuilding Co., Wilmington, Cal.	4	6	3,500
Coos Bay Shipbuilding Co., Marshfield, Ore.	4	6	3,500
Ralph P. Chandler, Wilmington, Cal.	4	4	3,500
Benicia Shipbuilding Corp'n, Benicia, Cal.	†3	2	3,500
Rolph Shipbuilding Corp'n, Humboldt Bay, Cal.	†7	2	3,500
Steel Vessels			
*Los Angeles Shipbuilding & Dry Dock Co., Los Angeles Harbor, Cal.	6	18	8,800
Moore Shipbuilding Co., Oakland, Cal.	7	20	9,400
		6	10,000
		7	9,070
Western Pipe & S. Co. of Cal., So. San Francisco, Cal.	4	18	8,800
Southwestern Shipbuilding Co., San Pedro, Cal.	4	10	8,800
Long Beach Shipbuilding Co. (Craig Shipbuilding Co.), Long Beach, Cal.	4	3	6,000
		2	3,000
Pacific Coast Shipbuilding Co., Suison Bay, San Franicsco, Cal.	4	10	9,400

DISTRICT No. 7—CALIFORNIA (*Continued*)

Shipbuilding and Yard Location	Shipways	Ships Under Contract	D.W. Tons
*Hanlon D. D. & Shipbldg. Co., Oakland, Cal...	3	6	5,350
		2	5,500
*Bethlehem Shipbuilding Corp'n, Ltd. (Union Iron Works), Alameda, Cal..............	7	12	10,100
		4	11,500
		2	11,800
*Bethlehem Shipbuilding Corp'n, Ltd. (Union Iron Works), San Francisco, Cal.........	§12		
Union Construction Co. (Union Indust. Works), Oakland, Cal........................	4	10	9,400

† One for private parties. ‡ Five for private parties. § Eight naval vessels.

DISTRICT No. 8—WASHINGTON

WOODEN VESSELS

Shipbuilding and Yard Location	Shipways	Ships Under Contract	D.W. Tons
*Sloan Shipyard Corp'n, Anacortes, Wash.....	6	16	3,500
Sloan Shipyard Corp'n, Olympia, Wash.......	†10		
*Grays Harbor M. S. Corp'n, Grays Harbor, Wash.	8	12	4,000
Sanderson & Porter, Wallapa Harbor, Wash....	5	10	3,500
*Grant-Smith-Porter S. Co., Aberdeen, Wash...	4	16	3,500
		2	3,500
Meacham & Babcock Shipbuilding Co., Seattle, Wash.	6	4	3,500
Nilsen & Kelez Shipbldg. Corp'n, Seattle, Wash.	3	4	3,500
*Seaborn Shipyards Co., Tacoma, Wash.......	4	8	3,500
Sabare Brothers, Tacoma, Wash..............	2	3	3,500
Wright Shipyards, Tacoma, Wash.............	3	4	3,500
Tacoma Shipbuilding Co., Tacoma, Wash......	4	4	3,500
*Puget Sound Brdg. & Drdg. Co., Seattle, Wash.	6	8	4,000
*Pacific American Fisheries, Bellingham, Wash.	5	5	3,500
Allen Shipbuilding Co., Seattle, Wash.........	2	1	3,650

STEEL VESSELS

Shipbuilding and Yard Location	Shipways	Ships Under Contract	D.W. Tons
*Skinner & Eddy Corp'n, Seattle, Wash......	5	20	8,800
		8	8,825
	5	8	8,825
Seattle Construction & Dry Dock Co., Tacoma, Wash. (Todd Shipyard)..................	5	10	7,500
*Seattle Const. & D. D. Co., Seattle, Wash.....	6	12	7,750
Erickson Eng. Co., Inc., Seattle, Wash.......	5	10	9,400
Ames Shipbldg. & D. D. Co., Seattle, Wash...	4	13	8,760
*J. F. Duthie & Co., Seattle, Wash.............	4	22	8,800
G. M. Standifer Const. Corp., Vancouver, Wash.	5	10	9,500
Northwest Steel Co. (Williamette Iron Works), Portland, Ore..............................	4	16	8,800
		15	8,800
*Columbia River Shipbldg. Corp., Portland, Ore.	2	8	8,800
		10	8,800
Albina Eng. & Mach. Wks., Inc., Portland, Ore.	6	4	3,800

† Two for private parties.

DISTRICT No. 9—GREAT LAKES

WOODEN VESSELS

Shipbuilding and Yard Location	Shipways	Ships Under Contract	D.W. Tons
*Lake & Ocean Nav. Co., Sturgeon Bay, Wis...	1	1	2,500

STEEL VESSELS

Shipbuilding and Yard Location	Shipways	Ships Under Contract	D.W. Tons
Saginaw Shipbuilding Co., Saginaw, Mich......	4	12	3,500
	3	5	3,550
The American Shipbldg Co.		3	4,200
		3	4,200
		4	3,550
*Chicago, Ill.....	6	5	3,550
		3	3,140
		20	4,200
		11	3,550
*Wyandotte, Mich	10	4	3,550
		12	3,270
		6	4,200
		8	3,550
*Cleveland, Ohio	3	2	3,550
		4	3,100
		6	3,550
*Superior, Wis..	6	6	4,200
		4	3,100
		11	3,550
*Lorain, Ohio..	10	18	4,200
		13	5,680
*Toledo Shipbuilding Co., Toledo, Ohio.......	4	8	3,550
	4	10	2,930
*Globe Shipbuilding Co., Superior Wis.........	4	6	3,500
		4	3,500
*Great Lakes Eng. Works, Ashtabula, Ohio....	3	30	4,200
*Great Lakes Eng. Works, Ecorse, Mich.......	8	31	3,850
*McDougall Duluth Co., Duluth, Minn........	4	10	3,500
		9	3,140
*Manitowoc Shipbuilding Co., Manitowoc, Wis.	6	9	3,400
		14	3,460
*Northwest Eng. Works (Hartman Grelling Co.), Green Bay, Wis.........................		2	Tugs
Whitney Brothers, Superior, Wis............		4	Tugs

DISTRICT No. 10—DELAWARE RIVER

STEEL VESSELS

Shipbuilding and Yard Location	Shipways	Ships Under Contract	D.W. Tons
Sun Shipbuilding Co., Chester, Pa............	†5	4	10,000
		16	10,070
New York Shipbuilding Corp'n, Camden, N. J.	‡24	3	10,000
		¶21	8,620
Chester Shipbuilding Co., Chester, Pa.........	†7	28	8,860
Wm. Cramp & Sons S. & E. B. Co., Philadelphia, Pa..............................	§9	9	6,860
New Jersey Shipbuilding Co., Gloucester, N. J.	7	12	5,000
*Pennsylvania Shipbldg. Co., Gloucester, N. J..	6	19	10,200

† One for navy. ‡ Three for navy. § Six for navy. ¶ Ten destroyers.

DISTRICT No. 11—OREGON

WOODEN VESSELS

Shipbuilding and Yard Location	Shipways	Ships Under Contract	D.W. Tons
G. M. Standifer Const. Corp., Vancouver, Wash.	6	6	4,500
G. M. Standifer Const. Corp., Portland, Ore...	4	10	3,500
Peninsula Shipbuilding Co., Portland, Ore.....	4	4	4,000
		4	3,500
Coast Shipbuilding Co., Portland, Ore........	4	4	3,500
		4	3,500
Supple & Ballin, Portland, Ore...............	4	8	4,000
Sommarston Shipbldg. Co., Columbia City, Ore.	4	4	3,500
Wilson Shipbuilding Co., Astoria, Ore.........	4	6	3,500
Geo. F. Rodgers & Co., Astoria, Ore.........	4	4	3,500
St. Helens Shipbuilding Co., St. Helens, Ore...	4	2	3,500
Feeney & Bremer Co., Tillamook, Ore.........	4	1	3,500
McEachern Ship Co., Astoria, Ore...........	6	10	3,500
Grant Smith Porters S. Co., St. Johns, Ore.....	8	12	3,500

INDEPENDENT OF DISTRICTS

FABRICATED STEEL SHIPBUILDING PLANTS

Shipbuilding and Yard Location	Shipways	Ships Under Contract	D.W. Tons
American International Shipbuilding Corp'n, Hog Island, near Philadelphia, Pa.........	50	110	7,500
		70	9,000
Merchants Shipbuilding Corp'n, Bristol, Pa.....	12	60	9,000
Carolina Shipbldg. Corp'n, Wilmington, N. C...	4	12	9,600

CONCRETE SHIPBUILDING PLANTS

Shipbuilding and Yard Location	Shipways	Ships Under Contract	D.W. Tons
Fougner Amer. S. Co. S. B. Corp'n, North Beach, L. I............................	1	1	3,500
Liberty Shipbuilding Co., Wilmington, N. C...	4	8	3,500–7,500
Liberty Shipbuilding Co., Brunswick, Ga......	1	1	3,000
San Francisco Shipbldg. Co., San Francisco Bay.		8	7,500
Total	834	1,977	13,718,850

Year's Output of American Shipyards Amounts to 1,430,793 Gross Tons

MERCHANT vessels built in the United States during the fiscal year ended June 30, as officially returned to the Commerce Department, Bureau of Navigation, numbered 1,622, of 1,430,793 gross tons. The output of the past four months, 706,084 gross tons, almost equaled that of the preceding eight months, and is greater than any previous annual output in our history.

The year's output is more than double the largest output of German shipyards in peace times. The output of the United Kingdom for the 12 months ended June 30 has not been stated, but for the 12 months ended May 31 it was 1,406,838 gross tons, or about 70 percent of the annual output of peace times.

Of the year's American output, 253 of 1,034,604 gross tons were sea-going steel steamers, 157 of 213,088 gross tons sea-going wooden vessels, and the remainder were vessels for the lakes, rivers, and domestic transportation. One concrete sea-going steamer of 3,427 gross tons is included.

The year's output is almost exclusively from established private shipyards, as the great shipbuilding plants like Hog Island, established through Government co-operation, had not begun to add finished ships to the cargo fleets to win the war.

BUILT FOR FOREIGN OWNERS

The vessels covered by the year's official returns to the Commerce Department, Bureau of Navigation, are almost wholly ships building or contracted for by private shipowners, American, British, French, or Norwegian, and in the main requisitioned by the Shipping Board, as relatively small tonnage originally contracted for by the Government was finished, but will appear in large volume in the new fiscal year's returns.

Of the year's output 48,364 gross tons were built for and delivered direct to foreign owners.

OUTPUT IN PREVIOUS YEARS

As shown in Table II, the output for six-month periods, beginning with July, 1916, was as follows: July-December, 1916, 320,676 gross tons; January-June, 1917, 491,983 gross tons; July-December, 1917, 542,313 gross tons; January-June, 1918, 888,480 gross tons. The output for the current year will therefore far exceed that for the previous twelve months.

TABLE I.—NUMBER AND TONNAGE

Gross Tonnage of Merchant Vessels Built in the United States (including those for Foreign Owners) and Officially Numbered During Successive 12-Month Periods, beginning with the 12 Months which Ended June 30, 1916.

	Seagoing.						Grand Total, including Non-Seagoing.	
	Steel.		Wood.		Total.			
	Number.	Gross.	Number.	Gross.	Number.	Gross.	Number.	Gross.
1916.								
June	....	......	....	......	....	......	1,030	347,147
July	....	......	....	......	....	......	1,012	361,313
August	....	......	....	......	....	......	1,042	398,671
September	....	......	....	......	....	......	1,057	424,058
October	....	......	....	......	....	......	1,086	476,922
November	....	......	....	......	....	......	1,124	537,683
December	....	......	....	......	....	......	1,179	555,262
1917.								
January	....	......	....	......	....	......	1,230	602,449
February	....	......	....	......	....	......	1,258	606,891
March	....	......	....	......	....	......	1,314	630,508
April	....	......	....	......	....	......	1,367	683,725
May	....	......	....	......	....	......	1,445	713,071
June	114	468,502	80	131,449	194	599,951	1,546	812,659
July	124	513,567	84	143,778	208	657,345	1,630	871,080
August	128	537,804	93	152,765	221	690,569	1,681	904,354
September	132	547,325	100	162,646	232	709,971	1,688	942,516
October	130	553,975	115	184,287	245	738,262	1,693	962,969
November	139	538,206	123	192,515	252	730,721	1,701	949,601
December	142	605,738	137	211,830	279	817,568	1,699	1,034,296
1918.								
January	144	607,404	137	211,626	281	819,030	1,657	1,025,496
February	157	682,867	146	222,723	303	905,590	1,669	1,106,093
March	180	759,354	153	238,051	333	997,405	1,670	1,194,127
April	203	845,338	157	236,498	360	1,081,836	1,668	1,278,132
May	232	966,850	151	219,947	383	1,186,797	1,661	1,381,369
June	253	1,034,604	157	213,088	410	1,247,692	1,622	1,430,793

TABLE II.—OUTPUT BY MONTHS

Vessels Built and Officially Numbered in the United States from July, 1916, including Vessels Built for Foreign Owners.

Months.	Seagoing.						Non-Seagoing.		Grand Total.	
	Steel.		Wood.		Total.					
	Number.	Gross.	Number.	Gross.	Number.	Gross.	Number.	Gross.	Number.	Gross.
1916.										
July	4	9,826	3	1,784	7	11,610	114	19,121	121	30,731
August	5	22,479	5	3,168	10	25,647	114	27,121	124	52,768
September	5	25,552	5	2,632	10	28,184	84	10,239	94	38,423
October	15	37,770	7	14,238	22	52,008	95	18,224	117	70,232
November	20	66,429	3	2,644	23	69,073	86	21,563	109	90,636
December	4	18,385	2	1,296	6	19,681	81	18,205	87	37,886
Total	53	180,441	25	25,762	78	206,203	574	114,473	652	320,676
1917.										
January	10	52,082	6	6,672	16	58,754	83	14,841	99	73,595
February	4	18,779	5	6,777	9	25,556	63	11,448	72	37,004
March	6	38,553	5	5,448	11	44,001	126	15,110	137	59,111
April	8	44.653	11	22,570	19	67,223	148	11,822	167	79,045
May	11	36,086	19	33,004	30	69,090	162	22,137	192	91,227
June	22	97,908	9	31,216	31	129,124	196	22,877	227	152,001
Total	61	288,061	55	105,687	116	393,748	778	98,235	894	491,983
July	14	54,891	7	14,113	21	69,004	184	20,148	205	89,152
August	9	46,716	14	12,155	23	58,871	152	27,171	175	86,042
September	9	35,073	12	12,513	21	47,586	80	28,999	101	76,585
October	13	44,420	22	35,879	35	80,299	87	10,386	122	90,685
November	19	50,660	11	10,872	30	61,532	87	15,736	117	77,268
December	17	85,917	16	20,611	33	106,528	52	16,053	85	122,581
Total	81	317,677	82	106,143	163	423,820	642	118,493	805	542,313
Total 1917	142	605,738	137	211,830	279	817,568	1,420	216,728	1,699	1,034,296
1918.										
January	12	53,748	6	6,468	18	60,216	39	4,579	57	64,795
February	17	94,242	14	17,874	31	112,116	53	5,485	84	117,601
March	29	115,040	12	20,776	41	135,816	97	11,329	138	147,145
April	31	130,637	15	21,017	46	151,654	119	11,396	165	163,050
May	*40	157,598	13	16,453	53	174,051	132	20,413	185	194,464
June	43	165,662	15	24,357	58	190,019	130	11,406	188	201,425
Total	172	716,927	75	106,939	247	823,872	570	64,608	817	888,480

* Includes 1 cement vessel of 3,427 gross tons.

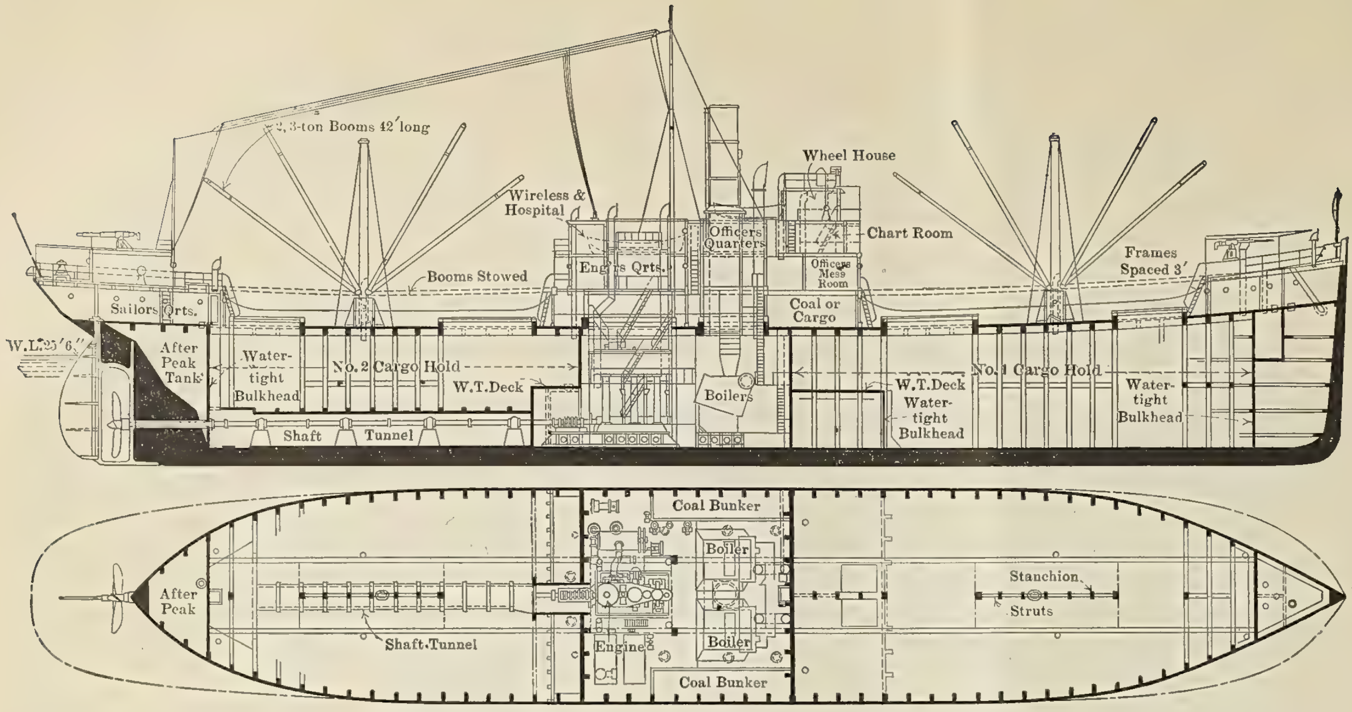


Fig. 1.—Inboard Profile and Hold Plan of 3,500-Ton Concrete Ship

Concrete Ship of 3,500 Tons Deadweight Designed by Emergency Fleet Corporation

IN a special report to the Chairman of the Shipping Board, R. J. Wigg, chief engineer, Department of Concrete Ship Construction, Emergency Fleet Corporation, sums up the conclusions of the Concrete Ship Department as to the advisability of constructing concrete ships as follows:

(1) The reinforced concrete ship can be built structurally equal to any steel ship.

(2) The available information assures, with all the certainty possible short of actual experience under service conditions, that the concrete ship will be durable for several years, assuring satisfactory service throughout the probable duration of the present war.

(3) The cost of the reinforced concrete ship complete will vary between $100 (20/16/8) and $125 (26/0/10) per ton deadweight, depending upon the number of ships built

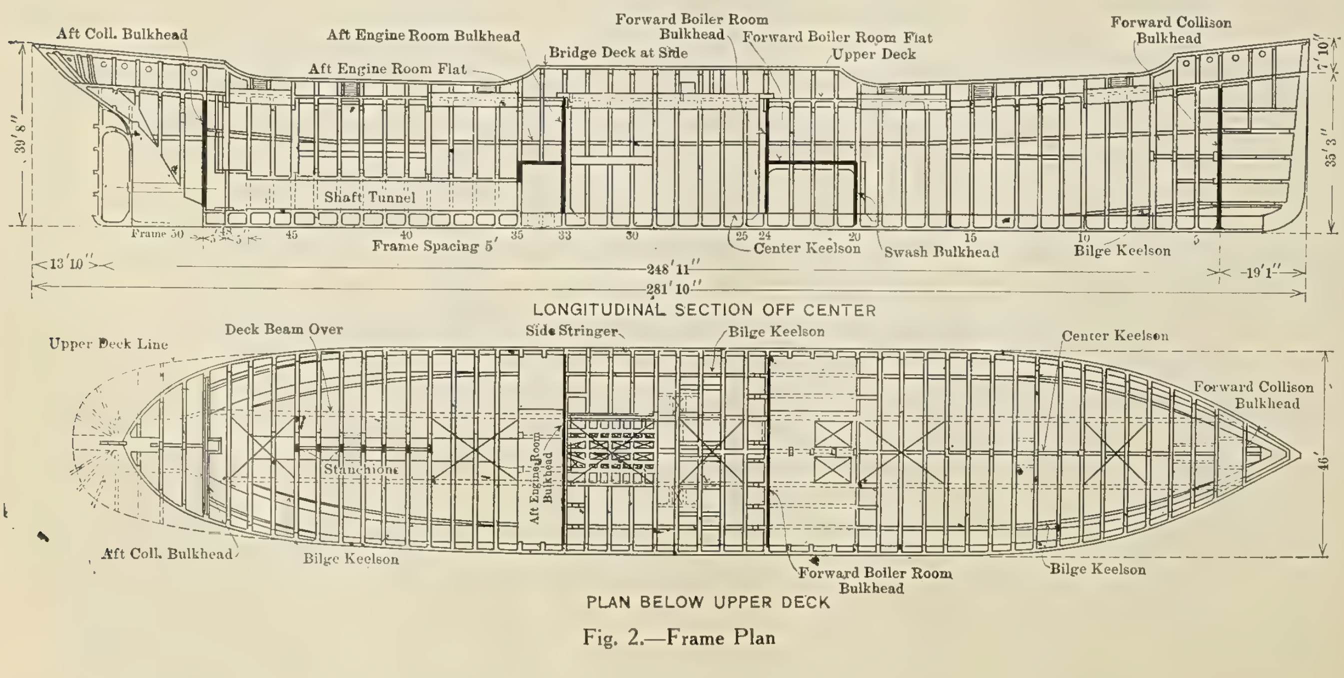
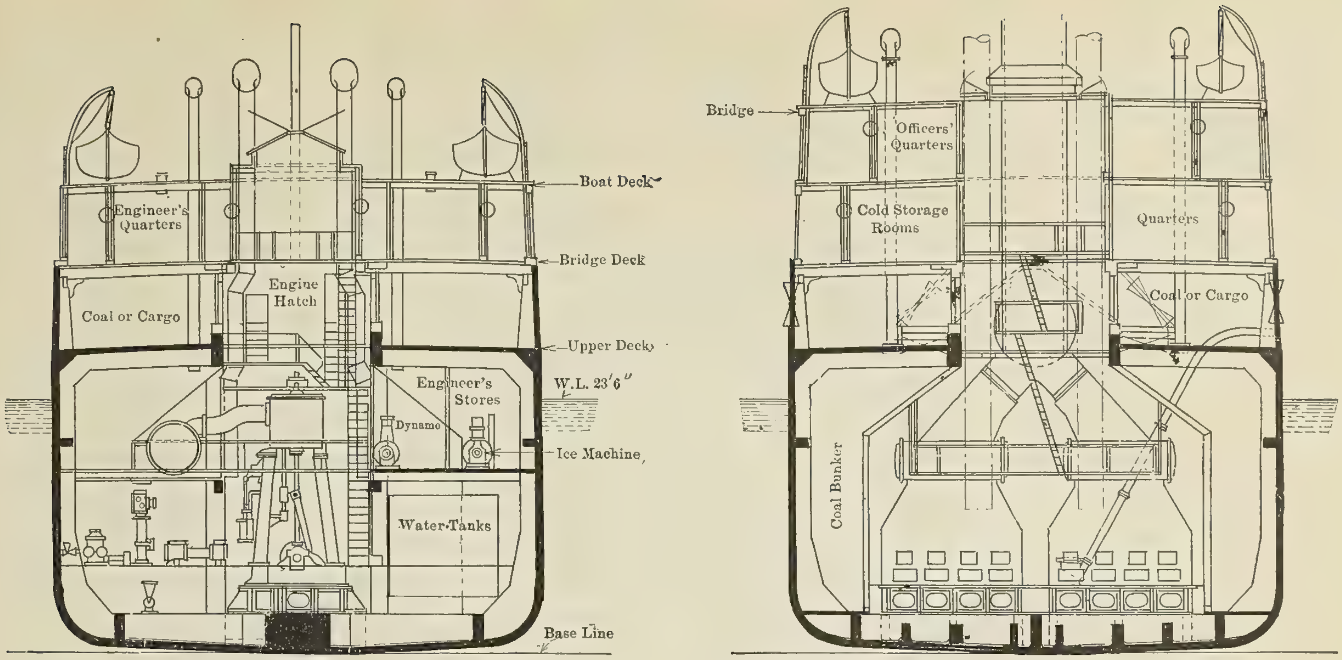


Fig. 2.—Frame Plan



Section Through Engine Room (Looking Forward) Section Through Boiler Room (Looking Aft)

Fig. 3.—Sections Through Machinery Space

and the conditions of construction. The cost of the hull only will be between $30 (6/5/0) and $40 (8/6/8) per ton deadweight.

(4) The construction of concrete hulls will not interfere with the present programme for the construction of steel and wood hulls in so far as labor or materials are concerned.

(5) The Concrete Ship Department has completed the detailed plans for a 3,500-ton concrete ship, so that construction of such ships can start immediately.

(6) It is estimated that between one hundred and fifty and two hundred 3,500-ton concrete hulls can, if construction is started immediately, be completed by December 31, 1918, totaling approximately 600,000 tons.

(7) It is further estimated, if the construction of yards is begun immediately and the construction of hulls of

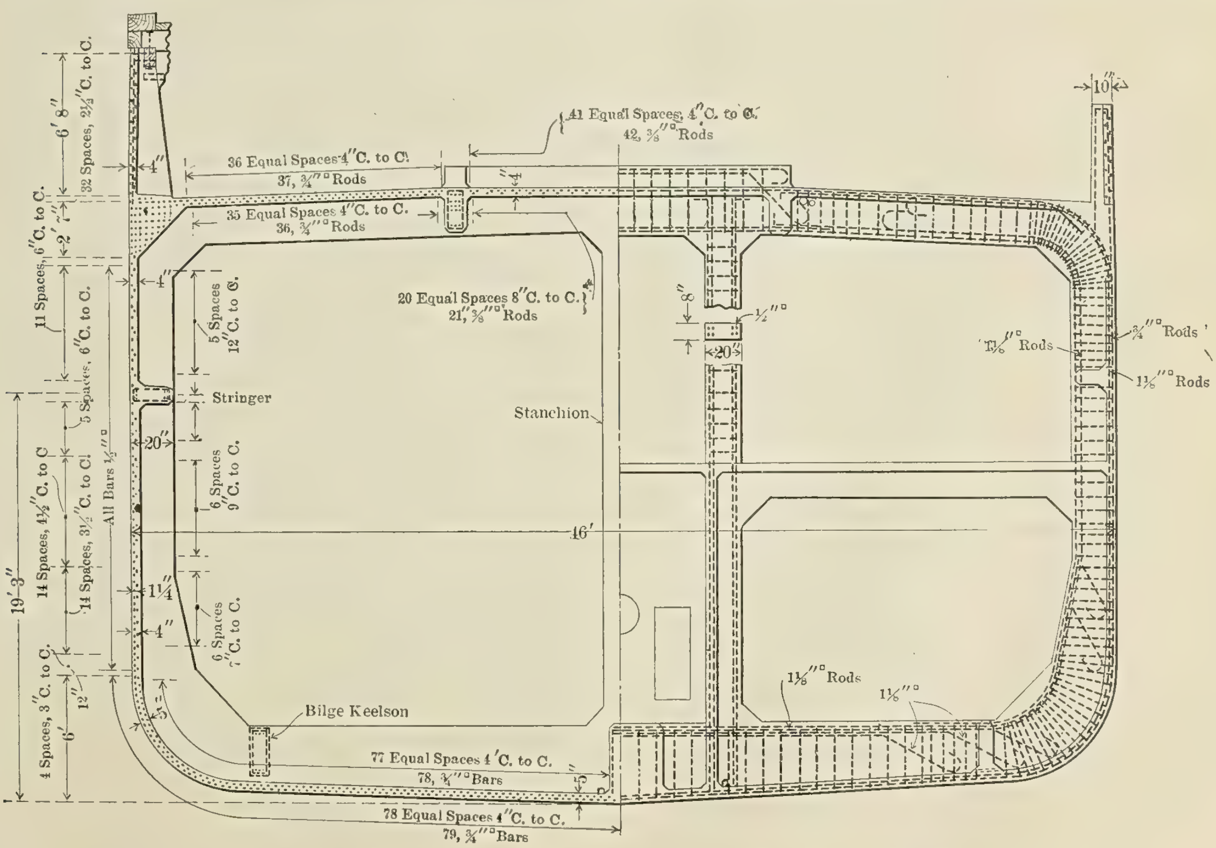


Fig. 4.—Midship Section, Showing Shell Reinforcement and Frame Details

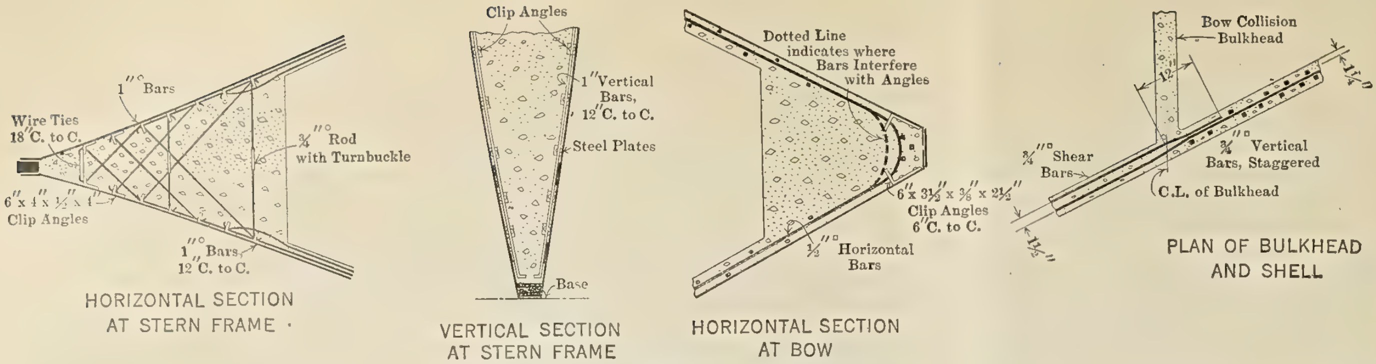


Fig. 5.—Construction Details at Stem and Stern

7,500 tons each commences by June, 1918, that two hundred and fifty can be completed by August, 1919.

The 3,500-Ton Concrete Ship

The standard concrete ship of 3,500 tons deadweight carrying capacity is of the same size, dimensions and form as the 3,500-ton standard wood ship (designed on page 294, Marine Engineering, July, 1917) except that the sheer line amidships has been slightly altered and no outer keel is fitted. The general arrangement follows closely that of the wood ship, including the number and location of bulkheads.

The propelling machinery design for the wood ship has been provided for without essential change in this vessel.

The principal dimensions of the concrete ship are as follows:

Length overall	281 feet 10 inches
Length between perpendiculars	268 feet
Beam, over shell	46 feet
Depth, amidships, on side	28 feet 3 inches
Draft	23 feet 6 inches
Full load displacement	6,175 tons

The comparative weights of similar ships built of concrete, wood and steel are given in Table I.

TABLE I.—COMPARATIVE WEIGHTS, CONCRETE, WOOD, AND STEEL VESSELS

	Concrete	Wood	Steel
Hull	2,500	2,300	1,160
Fittings, outfit, and equipment	191	191	180
Propelling machinery	206	206	200
Margin	75	80	60
Ship (light)	2,972	2,777	1,600
Reserve feed	80	80	80
Ordnance	23	23	23
Fuel	300	300	300
Stores	40	40	40
Cargo	2,760	2,180	3,057
Total deadweight	3,203	3,123	3,500
Full-load displacement	6,175	5,900	5,100
Percentage deadweight to full-load displacement	52	53	68.6

Metacentric Height, Stability and Period of Roll

The metacentric heights in the light (ship without cargo) and full load conditions are, respectively, 2.15 feet and 2.2 feet. The best practice at the present time places these values between the limits of 1 and 3 feet for vessels of this type and size.

The maximum righting arm occurs at 51.5 degrees and 46.5 degrees for the vessel light and fully loaded, respectively, the extreme ranges being 89 degrees and 81.5 degrees respectively.

The freeboard amidships at the side is 4 feet 9 inches.

While an investigation of the period of roll is a laborious operation of doubtful value and seldom attempted in the design of steel vessels, the Concrete Ship Department, nevertheless, considered it safe to say that the concentration of relatively great weight in the decks and shell in the case of the concrete vessel would aid materially in increasing the period of roll anticipated.

Strength of Hull

The strength of the ship as a girder supported on the crest of a wave amidships, hogging, and also on the crest of two waves, one at each end, sagging, was calculated for five conditions. The same basic conditions were assumed as to length, depth and form of waves and the same method of procedure that is standard practice in calculating the strength of steel ships was followed throughout. The maximum bending moments and fiber stresses in the steel reinforcements and concrete in the various conditions are given in Table 2.

TABLE II.—STRESSES IN GOVERNMENT 3,500-TON CONCRETE SHIP

Condition	Maximum Bending Moment Foot-Tons	Maximum Tons per Square Inch Fiber Stress in— Deck Reinforcement	Keel Reinforcement	Pounds per Square Inch Fiber Stress in Concrete
Ship without cargo, hogging	25,175	5.53	2.80[1]	728
Ship fully loaded, hogging	37,000	5.63	2.95[1]	766
Ship without cargo, sagging	14,400	1.28	2.63[2]	270
Ship light with enough cargo in forward hole to trim sagging	11,960	1.07	2.19[2]	210
Ship fully loaded, sagging	9,400	0.84	1.72[2]	70

[1] Keel [2] Deck

Good practice in steel merchant ships for a vessel of this type gives a maximum stress in the outer fiber of from 5 to 8 tons per square inch figured on the same basis as given above for the concrete ship. In addition to the stress due to the ship acting as a girder there is the local stress between frames, where the plating must act as a beam for that space. This action is seldom taken account of in steel ships but has been given full consideration in the design of the 268-foot concrete ship.

Local Strength of Hull Members

Although the transverse strength of vessels is not usually investigated with any degree of accuracy, except in the case of naval vessels, as the scantlings are taken from the books of the classification societies, nevertheless, in the case of the concrete vessel the complete transverse section was figured by the Concrete Ship Department with numerous cases of loading and heeling for every frame. The strength of the transverse frames was investigated for a large number of conditions of loading and for various immersions of the vessel.

The transverse frames are designed to stand the outside water pressure—water to the gunwales—with minimum cargo load, for maximum cargo load and a sagging draft of 15 feet 6 inches and for listed positions with loading light and heavy. All of these conditions of loading are to be met by the frames with stresses not to exceed 1,500 pounds per square inch in the steel.

The results of the analysis agree with those of Dr. Bruhn published in the Transactions of the Institute of Naval Architects, 1901 and 1904. From Dr. Bruhn's analysis it is clear that the design of the concrete frame is so made that the frame is working at the above-noted safe stresses under loadings that would develop double the steel stresses in a standard steel frame of similar dimen-

sions. In steel ships, this local action between frames would increase the stresses in the bottom plating of the ship acting as a girder from 5 to 10 tons, and in many cases to a much higher figure.

In this concrete ship design the tensile strength in the reinforcement, due to local bending, amounts to about 3 tons per square foot, bringing the total up to slightly less than 8 tons.

The bulkheads have been designed to carry a head of water on either side up to the deck. The collision bulkheads fore and aft were designed for 1,500 pounds per square inch in the concrete and 16,000 pounds per square inch in the steel. The steel stress in the engine room bulkheads was advanced to 20,000 pounds per square inch.

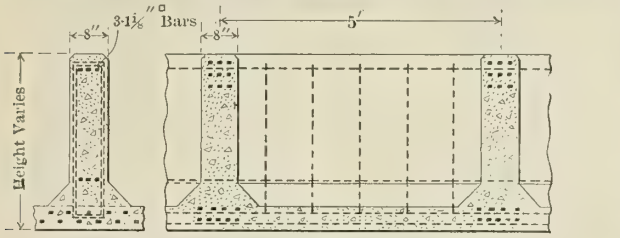


Fig. 6.—Sections Through Bilge Keelson

In the design of bulkheads for steel ships it is common practice to allow a unit stress in the steel of 22,000 to 23,000 pounds per square inch.

The deck is designed to carry 5 feet of water or equivalent, which is in excess of loading on the decks of standard steel ships being built by the Emergency Fleet Corporation.

Hull Construction

As shown by the drawings, the parallel middle body of the hull extends 35 percent of the length. There is a dead rise of 9 inches. The hull is subdivided into five watertight compartments by four transverse watertight bulkheads and the bottom is strengthened by a center keelson and two bilge keelsons, while the sides of the vessel are strengthened by side stringers at about the middle depth of the hull.

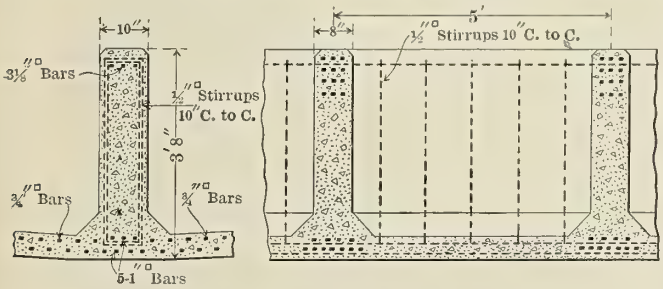


Fig. 7.—Sections Through Center Keelson

The keelsons consist of concrete girders reinforced with rods in the upper and lower sections and are tied together with frequently spaced stirrups. The keelsons are worked into the transverse frames.

The frames, spaced 5 feet apart, are also reinforced concrete girders and are continued at the main deck to form the deck beams supporting the main deck, which is made of reinforced concrete slabs 4 inches thick.

The shell of the vessel is 5 inches thick on the bottom and up to 6 feet above the base line, while the remainder is 4 inches thick. The shell is reinforced at the outer and inner edges with ½-inch to ¾-inch square bars

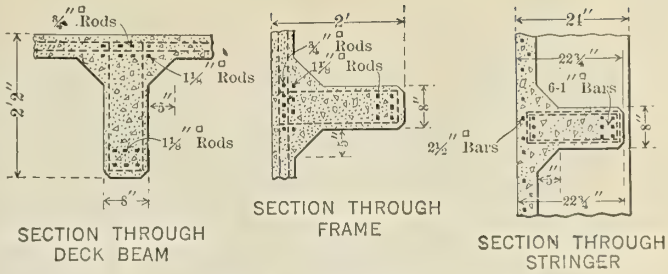


Fig. 8.—Structural Details

parallel to the waterline and spaced from 4 inches to 12 inches between centers. The horizontal reinforcing rods are located 1¼ inches from the face of the concrete shell. Vertical ¾-inch shear bars are also fitted between the horizontal rods extending clear around the shell and deck.

Between the hatches in the cargo holds the deck beams are supported by reinforced concrete stanchions. The foundations for the machinery consist of steel plate girders seated on extra heavy framing consisting of longitudinal reinforced girders.

As previously stated, the hull is subdivided by four transverse watertight bulkheads, two of which are the collision bulkheads and two inclosing the machinery space. The bulkheads consist of concrete slabs reinforced with transverse and longitudinal steel and stiffened by vertical stringers and beams which are tied into the main frames and deck beams.

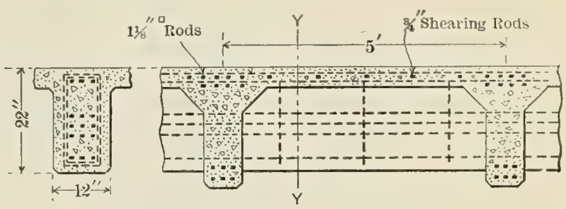


Fig. 9.—Sections Through Deck Beams

Storage of Bituminous Coal

The more general storage of coal during the summer months is coming to be recognized as the only practical means of avoiding a coal shortage during the winter. Many corporations and individuals will this year undertake, for the first time, to store large quantities of coal. The storage of bituminous coal presents certain difficulties because of its tendency toward spontaneous combustion, with its attendant dangers and losses. The methods to be employed in avoiding spontaneous combustion have not generally been well understood, and those which have seemed successful in some cases have failed in others.

The Engineering Experiment Station of the University of Illinois has just completed a study of the problems involved in coal storage and has published the results in a 200-page illustrated book designed as Circular No. 6, "Storage of Bituminous Coal." The study was made under the direction of H. H. Stoek, professor of mining engineering. The reasons and advantages of storing coal are given, the kinds and sizes of coal which may be safely stored are described, and the many factors entering into successful storage are discussed.

Copies of Circular No. 6 may be had by addressing the Engineering Experiment Station, Urbana, Illinois. The price is forty cents per copy.

Fig. 1.—Outside Forms Erected for Pouring Concrete Barge at Peekskill Shipyard

Concrete Barges*

Brief Description of Design, Method of Construction, Materials Used, Method of Waterproofing and Launching of Concrete Barge

BY LOUIS L. BROWN†

THE first concrete boat built by the Louis L. Brown Company, New York, was a deck barge 112 feet long, 33 feet wide and 10 feet deep. It has 18 inches shear and 2 inches camber in the deck. The boat is divided into six compartments by one longitudinal and two transverse bulkheads. The bottom and deck beams are carried by longitudinal reinforced concrete trusses. The panel length of these trusses was 7 feet center to center,

Fig. 2.—Concrete Barge Ready for Launching

and the depth equal to the depth of the boat. They are spaced 5 feet 4 inches apart across the width of the boat and are reinforced to take care of any hogging or sagging strains due to the following conditions:

1—The central third of the boat loaded with the end thirds light.

2—The end thirds loaded and the center third light.

3—One-third the load on one end of the boat.

4—The ends of the boat supported on the crest of a wave equal in height to 1/20 its length.

5—The center of the boat supported on the crest of a wave equal in height to 1/20 its length.

6—The boat light supported in the extreme ends with no buoyancy.

The bottom, sides and deck slabs are 2¾ inches thick, supported by beams 3 feet 6 inches center to center. The cabin deck bulkheads and fenders are built of wood. The stress used in the design are:

Reinforcing steel—16,000 pounds per square inch.

Extreme fibre stress in concrete—800 pounds per square inch.

Allowable shearing stress in plain concrete—50 pounds per square inch.

Allowable shearing stress in beams reinforced with bent-up rods and stirrups—125 pounds per square inch.

Allowable bond stress—100 pounds per square inch.

The boat was built for side launching. The building ways were spaced 14 feet center to center. The forms were built in panels and bolted together. The bottom panels which were carried by the building ways were supported at the ends by wedges, which permitted them to be removed before removing the building ways.

As the cement gun was used in concreting the sides and bottom only one form was necessary. This was placed on the outside of the boat. The materials used were mixed dry in a batch mixer and conveyed to the guns, located so as to cover the entire boat.

All materials were tested and favorably reported for use for concrete in sea water by the Pittsburgh Testing Laboratory.

The proportions used in the mix varied. In the bottom it was one part by volume of cement, 1½ parts by volume of sand and two parts by volume of limestone screenings. In the sides the mix was one part by volume of cement to 1½ parts by volume of sand. In the interior beams, trusses and deck it was one part by volume of cement, 2 parts by volume of sand and two parts by volume of limestone screenings. The limestone screenings were screened through a ¼-inch screen and were well graded in size Giant Portland cement was used throughout in the construction of this boat.

The reinforcement used in all slabs and bulkheads was Clinton electric weld galvanized wire mesh No. 3 and 8 wire spaced 2 inches by 16 inches. All reinforcing rods used in the beams were Havemeyer bars. This reinforcement, together with the forms for the bottom beams and the ribs in the side, was supported from the top by beams spanning the width of the boat.

* Paper read before American Concrete Institute, Atlantic City, N. J., June 29.

† Louis L. Brown Company, Inc., 30 Church Street, New York.

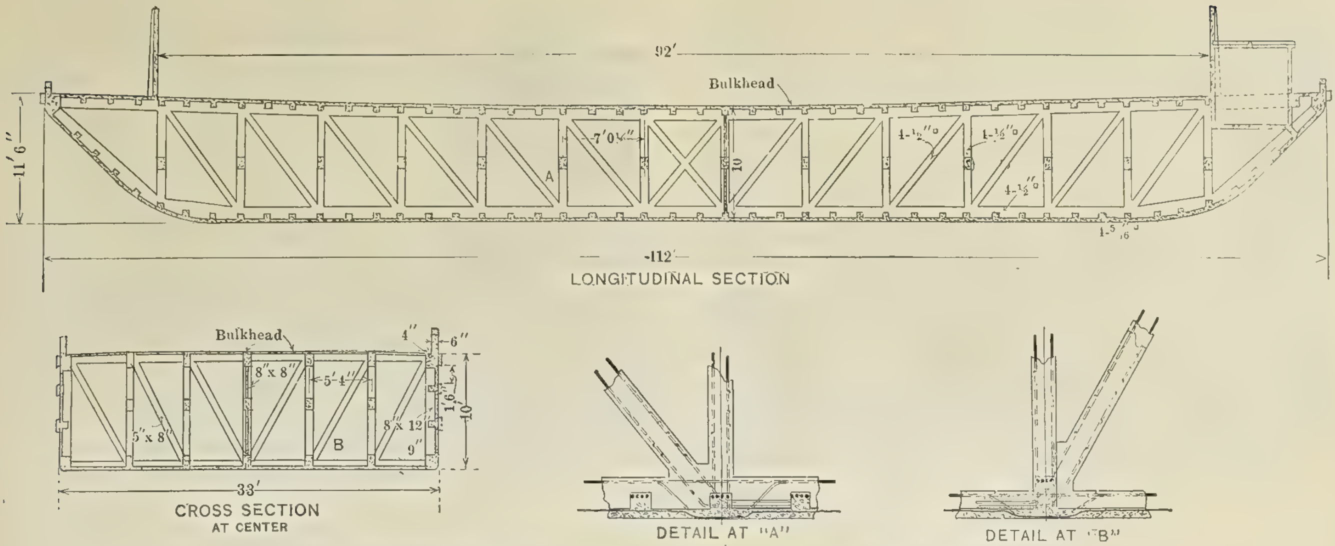


Fig. 3.—Longitudinal Section, Midship Section and Details of Strut Construction

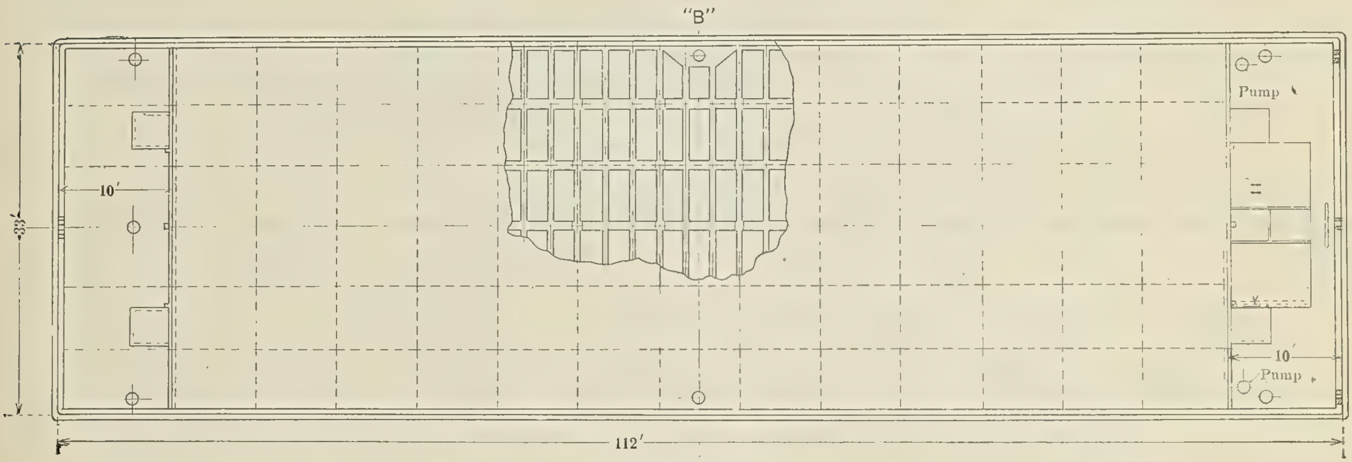


Fig. 4.—Deck Plan

The concrete was applied in the outer hull in three operations.

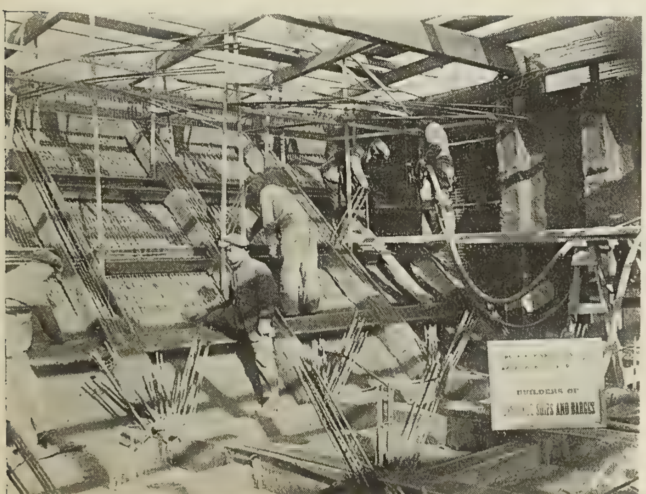
First, the bottom slab and beams were concreted.

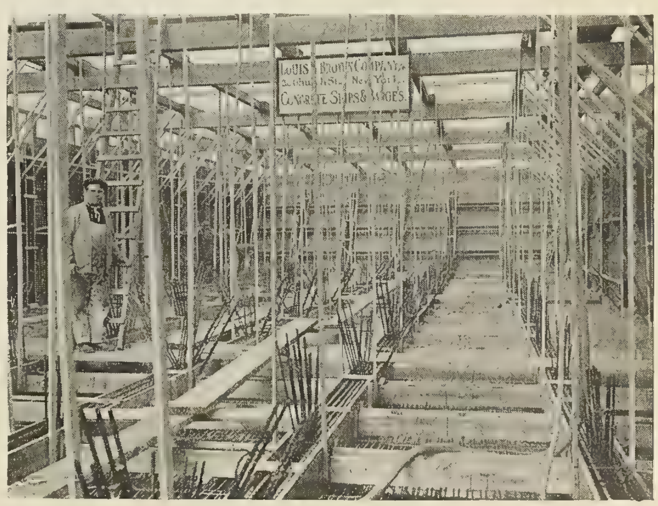
Second, the side slab and beams for approximately ½ the height of the sides and the

Third operation completing the sides.

It was necessary to concrete the sides in two operations as it was found in attempting to concrete a vertical slab of this thickness with the cement gun for a greater height than about 5 feet that there was a decided tendency for the concrete drag or pull down, causing it to crack before it had set. The remainder of the boat was poured in two operations.

The bitts were made of 10-inch pipe with holes through





Figs. 5 and 6.—Building Molds Around Struts and Diagonals at Ends and Amidships

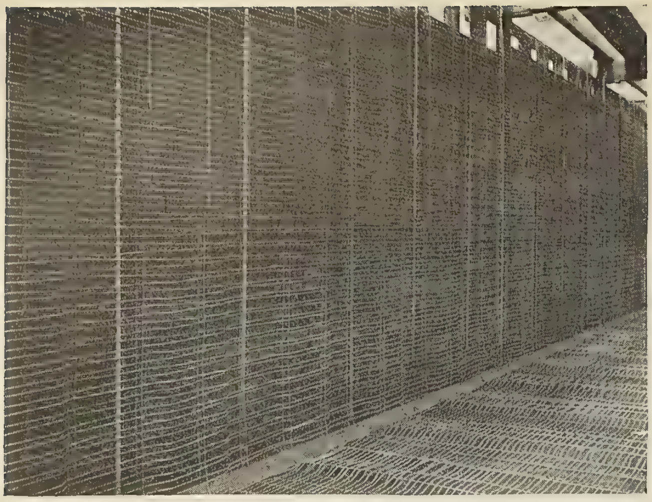


Fig. 7.—Reinforcing Rods on Side and Bottom of Barge

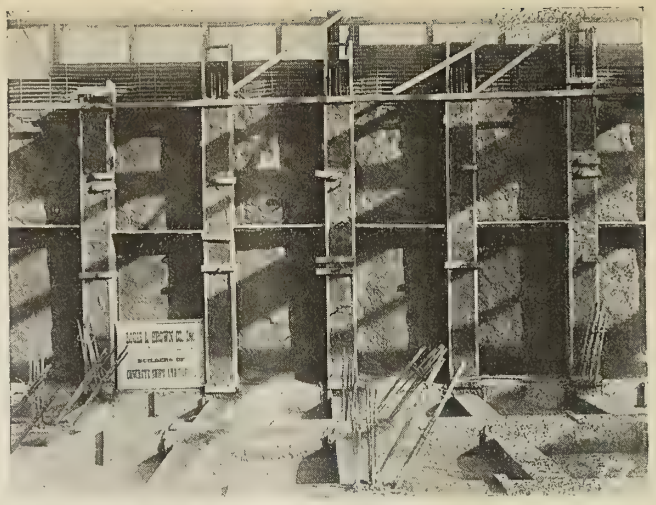


Fig. 8.—Removing the Molds After Pouring the Concrete

the bottom and sides for reinforcing rods, which spread out on the deck.

Three sets of 6-inch by 8-inch fenders were attached to the sides of the boat by bolting through the frames. Holes were provided in the concrete for the bolts by wooden pegs placed in the forms before concreting. After the forms were removed the pegs were bored out of the concrete. Marine glue made by the New-Pro Chemical Company was heated and poured into the bolt holes and the bolt for attaching the fenders was inserted while the glue was hot, the glue filling any space between the bolt and the concrete.

It was intended to launch this boat in the Fall of 1917, but upon removing the outside and bottom forms it was found that the product obtained by the use of the cement gun was not sufficiently uniform to insure a watertight hull. It was necessary to go over the boat very thoroughly and remove the sand pockets or defective concrete and replace with new concrete.

While the writer believes that it is possible to build a watertight hull with the cement gun with less sand pockets than was encountered in the construction of this boat, he does not believe, even under the most favorable conditions as to the design of the boat and in the operation of the gun, that sand pockets can be entirely eliminated. After all the defective concrete was replaced, the hull was painted with a neat cement grout, which was thoroughly rubbed into the pores of the concrete.

Four launch ways were used in launching, spaced so as to divide the load as equally as possible. The declivity of the ways was ¾ inch per foot, and the pressure was approximately 2½ tons per square foot of way. The launching was very successful, and the boat draws 3 feet 8 inches of water when light, and shows no leakage.

After having made a thorough study in the design and in the methods of construction of concrete barges, the writer believes that there are no difficulties that cannot be overcome, and that eventually reinforced concrete will prove to be the desirable material for the construction of barges and other floating craft, both from the point of view of first cost and for serviceability.

Concrete Shipyard at Wilmington, N. C.*

Description of Plant Erected by Liberty Shipbuilding Company, Boston, Mass., for Building Concrete Ships

A. G. MONKS†

THERE is little experience yet in design of concrete ships and less in design of plants as compared with the well-established building of steel or wooden ships. Changes and improvements may confidently be expected. At this date the reproduction in concrete of the framing and the form of steel ships has been wisely adopted, and has been followed by the British engineers and is advised by the Joint Committee of the American Concrete Institute and the Portland Cement Association and conservative naval architects and engineers.

Controversy over the merits and demerits of design of ships, concrete for use in sea water, comparative costs of maintenance, initial costs of net cargo capacities with per ton costs of transportation, ultimate length of safe service and the final place the ships may occupy in the economics of ocean transportation are not good questions for forcing upon the now heavily overloaded public's mind. They are still open questions whose existence may well stimulate keenest rivalry for their solution by those who are chosen for that work, and as well those who are technically capable and have not yet been delegated to some phase of the question.

The Liberty Shipbuilding Company, of Boston, have one of the five agency contracts for concrete ships. These will be built at the yards at Wilmington, N. C. The fact

* From a paper presented at the Annual Meeting of the American Concrete Institute, Atlantic City, N. J., June 27-29.

† Monks & Johnson, Architects-Engineers, Boston, Mass.

that contract shipbuilding is still in the pioneer stage has determined the character of construction of the yard; which will be temporary, with light wooden construction.

Rapid changes in yard design and equipment and larger salvage of materials of yard and equipment will be possible, more rapid prosecution of the first shipbuilding itself can take place, and less initial cost will be incurred. An example of possible change of yard design is the use of steel forms (as the art of concrete shipbuilding advances). The design of the yard will also be governed by local conditions, the site, the market for building materials, the number and size of vessels to be built and the climate.

Discussion of this yard divides itself naturally into groups—the site, water basins and shipways; the concrete department, erecting machinery and the general storehouse; the traffic service of standard and narrow gage railways, paved truck roads and rolling stock; the timber department of storage open and enclosed and wood working buildings and machines; steel storage and steel working buildings; the general yard service of water, fire protection, sewerage and electricity and the provisions for the main office, the yard employees and the troops to be stationed at the yard.

Shipyard Site

The site is in the City of Wilmington, N. C., on the Cape Fear River, about 30 miles from the sea. A deep channel has recently been dredged by the site to a point above the city. The top soil is marsh mud, some fifteen to twenty feet deep, overlying sand and gravel base. The channel dredging furnished material for hydraulic sand fill over considerable portion of the thirty-five-acre site. Additional dredging between channel and site and from the launching basins will provide further fill. The site has a river frontage of 3,500 feet, about 1,400 feet of which is now being developed to a depth of eleven hundred (1,100) feet. Within this space provision is being made for four ways in the form of three launching basins with two piers having launching ways on both sides, parallel to the basins. The basins or docks are 460 feet long and 160 feet wide and are dredged to a depth of 20 feet at low water. The piers are 350 feet wide. Wooden piles with heavy timber capping support the ships during construction and launching. A heavy bulkhead at the pier edge retains the sand fill which forms the working deck. The pier slopes from high water level at opposite edges, at the rate of one and one-eighth inches per foot until it reaches the level of the central portion five feet above high water. The tankers are to be 420 feet long, 53 feet wide. They will be launched sidewise.

Storage of concrete materials with capacity for one ship will be on the piers between the building slips so as to serve a ship either side. The cement will be stored in bags in a wooden shed, and the sand and stone will be piled in the open.

Two single cubic yard concrete mixers, mounted on wheels, will be moved from ship to ship. When in operation, they will be placed between the materials and the ship. A spare mixer will be provided.

Shipyard Derricks

Two shipyard derricks located at the shipways will handle the forms, reinforcing steel, steel and iron castings, and concrete. These derricks will be of three-ton capacity, at 75 feet radius, with towers 50 feet high. Both will be in operation on one ship during the pouring of the concrete. At other times they will be used among the ships under construction as required. These derricks travel on rails 24 feet apart and have a wheel base of 24 feet. They can be moved from ship to ship by means of a transfer car running along the head of the docks. This car will be made strong enough to enable the derricks to be used while on the transfer car in unloading materials from lighters in the docks.

A general storehouse will be provided at the head of the basin between two piers, thus serving four ships. This will be an enclosed wooden building to house general supplies, rigging, tools, and spare parts for the yard machinery.

Transportation Facilities

The main line of the railroad enters the yard at the rear of one end and runs parallel with the river throughout the extent of the present development and can be extended if the yard is enlarged. From the main line spur tracks are run to the lumber storage and to the piers. One spur track runs through the steel storage and bending space, another runs in front of the general storehouse and along the form storage; other spurs serve the mold loft and carpenter shop. Thus every process in the yard is thoroughly served with standard gage railroad, except that the railroad used to take lumber from the storage piles to the saw mill and the carpenter ship is narrow gage. Paved roads parallel the railroad everywhere, and thus when cars or railroad may not be available automobile trucks will be used instead.

The yard will be provided with a small number of standard gage railroad cars and a locomotive. A larger number of narrow gage cars will be provided for handling lumber. The number of automobile trucks which will be required to supplement railroad transportation has not yet been determined.

Rough lumber storage is beside the yard's service railroad, and is in the open except as experience may call for roof over portions; adjoining is the sawmill for cutting to required sizes and for dressings; then lumber is taken to finished lumber storage with finished lumber purchased directly.

Shops

The mold loft is one story, 90 feet by 260 feet; the central bay 60 by 260 feet clear of posts; flooring of white pine carefully leveled constitutes a full-size drawing board on which the ship's lines are laid out and from these the molds or templates are made.

The carpenter shop is one story, wooden, sixty by two hundred feet, with an ell sixty by eighty feet near one end in which woodworking machinery is located. At the other end of the shop is a high portion in which bow and stern forms are built to full height. The machinery ell has enclosing side walls. This shop is located near the mold loft from which come the molds according to which the forms are built.

The oil process building will house oil dipping tanks and drain racks. The lumber for the facing of the molds will be the best seasoned stock obtainable. It will be shipped to us in closed cars, then dipped in linseed oil, then as assembled all joints are to be painted. The finished sections of flat forms will be dipped and the surface that has contact with the concrete will receive a final coat of paint.

Form storage buildings are to be merely shelter roofs and will be located close by the building ways. They will have enough space for the storage of forms for four ships. The flat pieces and panels will be piled up but the large built-up forms for the curved surfaces cannot be piled.

Reinforcing steel will be taken off the cars and placed in storage racks and will be sorted to size. Space will be provided for four thousand tons. About twelve hundred tons are required for each ship.

Cutting shears and bending tables will be under a

shelter roof: cut and bent steel will be taken on standard gage cars and stored in the open alongside the railroad tracks (at convenient places).

Water Supply, Fire Protection, Sewerage and Power

Water services, for manufacturing, drinking and sanitary purposes will be provided from the city supply. The city will bring this to the yard in a six-inch main and the shipbuilding company will provide its own distributing system.

Water for fire protection will be pumped from the river probably into an elevated tank to supply the automatic sprinklers and yard hydrants. It is expected that all buildings will be protected by automatic sprinklers, well placed hydrants and hose houses.

A city sewer now runs through the site and empties into the river. All sewerage and drainage of the yard will connect with this sewer or will empty directly into the river. Electricity both for power and for lighting will be purchased from the local public service company, who will completely install it.

An additional "breakdown" power station having capacity enough to light the yard (in case of a breakdown during the concreting of a ship) will be provided. The concrete is to be poured continuously from start to finish to avoid construction joints. It is expected that the pouring of one ship will take three or four days' continuous work. The lighting service covers the entire yard, the buildings and the protective fence about the yard.

Electric power will be used for the woodworking machines and for the steel bending machines. The mixers and derricks have their own steam power.

The gate house, employment office and first aid rooms, are of more or less standard arrangement. The gate house is designed to pass two thousand men. The restaurant is to be a two-story, wooden, fully supplied with screens, with kitchen on first floor and seats for two hundred and fifty men—provision has been made to double the capacity, if desired. The service will be caféteria. The second floor has a lunch room for the office force and a conference lunch room for department heads.

Military Protection

For the troops to be stationed at the yard, barracks with the requisite number of additional buildings, officers' quarters, cook-house, messhouses, etc., will be built. The presence of uniformed soldiers at the shipbuilding yard has been found to be important and beneficial, not only for the protection of the yard from marauders, but as a constant reminder to the men of the cause for which the shipbuilding work is being carried on.

The office building is two-story wooden, for the executive and clerical force of the Liberty Shipbuilding Company, its engineers and superintendent and the government engineer and auditor.

Side-Launching Ways

It was noted earlier that the ships are to be launched sidewise; one of the interesting features discussed between the Emergency Fleet Corporation and ourselves is the construction of the ways for side-on launching. It has been determined that this is preferable to end-on for several reasons, among them being that side-on can be used on narrow channels, and that a ship may be built on a level keel with greater ease in assembling forms, placing of steel, pouring of concrete and generally in the construction.

In end-on launching the stern of the ship entering the water first floats before the bow clears the ways. The ship is thus suspended by the bow and stern, and severe stresses are induced. The stresses of side-on launching are very much less severe. Again, a steel ship hull has attained its total strength at launching, but the concrete hull needs a longer period to reach its maximum strength. Side-launching has been used considerably on the Great Lakes and in other places, and is used on the Clyde for steel vessels due to the narrow channel.

The disadvantages of side-launching, which some regard as sufficient reason for preferring end-on, are that it is more difficult to reach the out-board side of the ship and to work there and enclosing structures to provide protection from the weather and supports for overhead traveling cranes is a great deal more expensive and the whole of one side has to be built removable, while in the case of end-on launching the doorway is much smaller.

Roofing over the ship during construction is necessary in the south on account of frequent showers, often followed by strong sunlight. This is particularly important during the process of concreting.

The mold loft is nearly completed, and we hope within ten days to be laying out the lines of the first 3,500-ton vessel.

Progress of Concrete Shipbuilding

A word on concrete shipbuilding elsewhere may fit properly in this paper:

Britain has six 1,150-ton deadweight capacity vessels building at Barrow-in-Furness, their design following the steel framing.

Spain is now building at Barcelona 40,000 tons in 300-, 500- and 1,000-ton sizes.

Norway continues to build lighters, sea tugs and small vessels by the Fougner-Ferro Concrete Shipbuilding Company, who have established also in New York and are building a 3,000-ton vessel under U. S. Government contract at Flushing, L. I.

The *Faith* is now nobly afloat and passing the tests well; The Liberty Shipbuilding Company is building a 3,000-ton vessel at Brunswick, Ga., under U. S. Government contract; the U. S. Shipping Board has let five agency contracts which will provide about 292,000 tons more capacity.

The total tonnage of concrete ships now being built or just contracted for is about 350,000 tons. This nearly equals the world's total loss for May. The loss by submarine and all other marine risks is given at 355,694. This comparison shows what a large factor the concrete ship has at once become.

The U. S. Shipping Board has decided on the complete try-out of concrete ships; has put the task up to the engineers and the builder; it is now ours to undertake it. It is now no longer a question of whether concrete ships can be made or whether they will ever replace steel and wooden ships; the vital question is to increase our total tonnage. We may depend on this being the basis of judgment of the Shipping Board when they adopted the programme.

The world's tonnage needed is in large figures. Mr. Hurley has publicly stated that America's share may be 25,000,000 tons by 1920. The net minimum tonnage to maintain an American soldier in Europe is given as five tons—apply this to 5,000,000 men, which our overseas army may reach, and the 25,000,000 tons which Mr. Hurley names is all absorbed to care for them.

The building of concrete ships is one of those engineering problems which have been forced to the forefront as war measures. I believe confidently that the engineers of the United States will solve this problem for the U. S. Shipping Board.

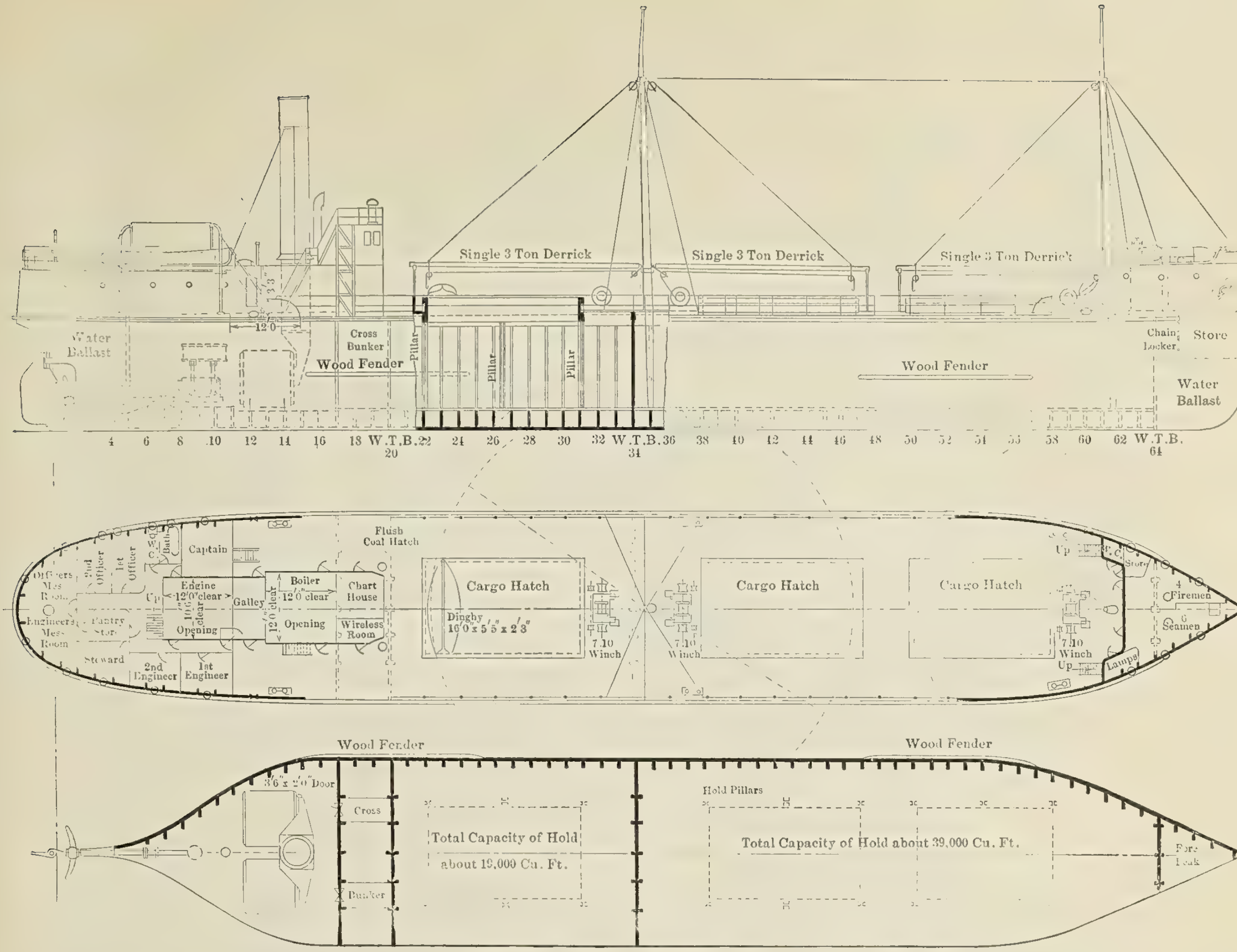


Fig. 1.—General Arrangement Ferro Concrete Cargo Boat; Length B. P., 205 Feet; Beam, 32 Feet; Molded Depth, 19 Feet 6 Inches

Design and Construction of Self-Propelled Reinforced Concrete Sea-Going Cargo Steamers now Building in Great Britain*

BY T. G. OWENS THURSTON

FOR years past one has heard of the construction of small vessels or barges of ferro-concrete, but these were never of sufficient size or importance to warrant closer investigation, and the whole subject appeared to be one that could safely be ignored so far as ocean-going ships were concerned.

The enormous losses of cargo-carrying ships during the war, coupled with the great scarcity of steel for shipbuilding on account of its diversion to other uses, have made shipbuilders endeavor to find some other material to replace steel for ship construction, even if only as a temporary measure; in this particular direction, shipowners have perhaps been really more progressive in their ideas than the shipbuilders. It was largely owing to shipowning friends of mine, who recognized the disastrous effect which the immense losses of mercantile tonnage would eventually have on the country, that steps were taken which led to the inception of the design and construction of the ships forming the subject of this paper. Without knowing anything as to the merits of ferro-concrete for shipbuilding purposes, they considered that if small craft had already been built with such material it was worth a trial, under present conditions, in larger ones, and after much consideration and investigation of the work previously done in this direction the author finally agreed with them.

The possibility of building wooden ships to make up for the scarcity of steel ships had been carefully considered, but it was found that although the timber supplies in certain countries were adequate for the purpose, a long time must elapse before green timber would be sufficiently seasoned to allow of its efficient use in ships'

* Paper read at the spring meetings of the fifty-ninth session of the Institution of Naval Architects, London, March 22, 1918.

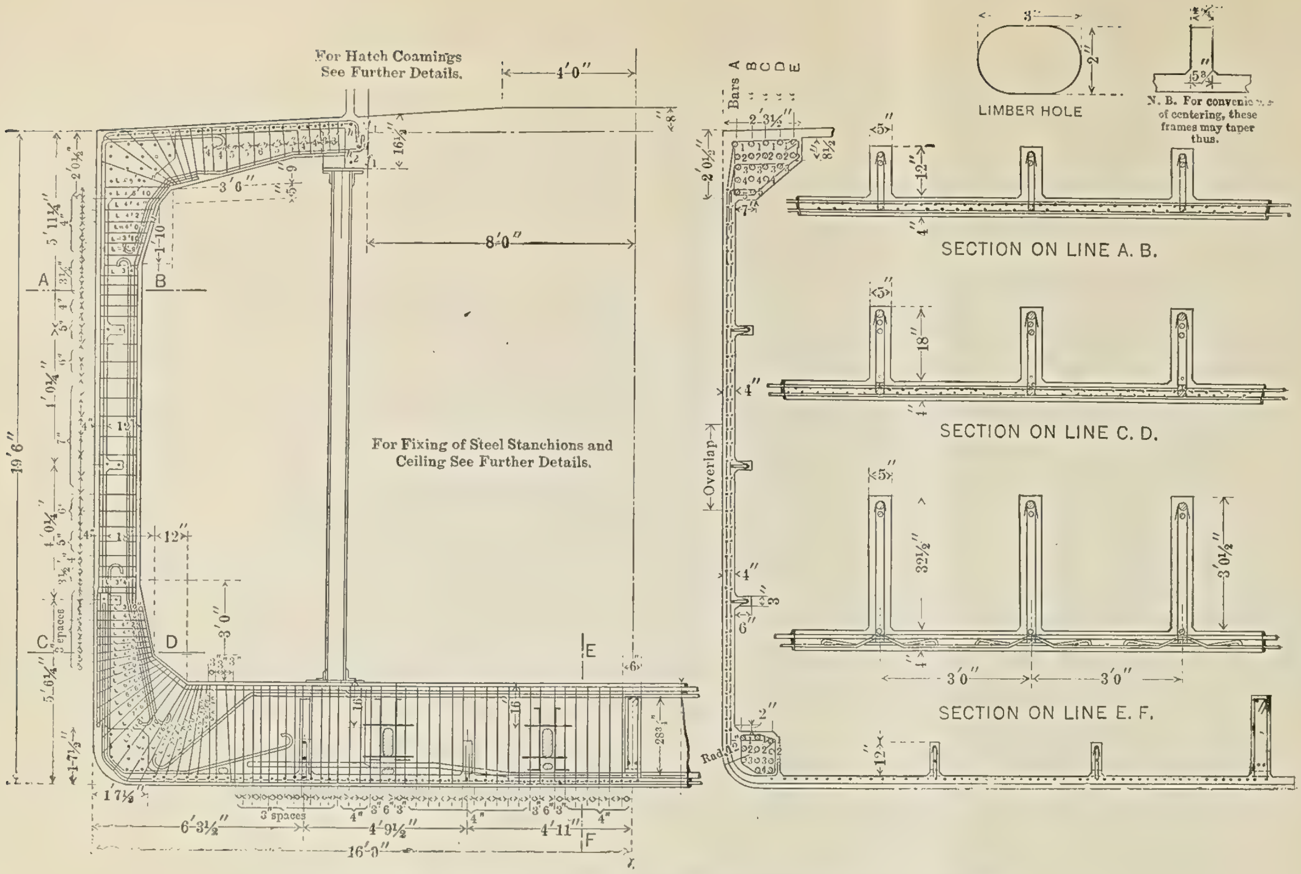


Fig. 2.—Middle Body Frames, Sides and Bottom from Stations 3½ to 8½

hulls, although in many cases such timber has been used, and has proved more or less satisfactory for a limited time. In addition to this, the problem of skilled labor would have been accentuated rather than relieved, as it was a practical impossibility to get a sufficient number of men skilled in wooden shipbuilding to allow of construction except on a very moderate scale. These and other considerations led us to abandon the idea of wooden shipbuilding as an efficient substitute under the present urgent circumstances in favor of ferro-concrete, the latter being a material which, if successful, would at once allow a large addition to be made to the present output of cargo-carrying tonnage. Moreover, the system of construction calls for a minimum amount of steel and a minimum amount of skilled labor. Such construction also reduces capital expenditure on yard plant, as it is much less costly than ordinary shipyard plant and requires less skilled attention. Another point in favor of ferro-concrete construction is that, compared with ordinary shipyard labor, there is not so great a variety of trades involved. For example, the same men who, at a later date, are employed on casting the hull, are in the initial stages utilized in casting and laying concrete blocks and in making ferro-concrete piles for the building berths and other necessary preliminary work, for which this material can be used extensively instead of timber or steel, both of which require skilled labor of different trades.

Although the suitability of ferro-concrete under present abnormal conditions and on economical considerations was apparent, its acceptability for ship construction had to be investigated from the naval architect's point of view. With this object in view, we decided to design a sea-

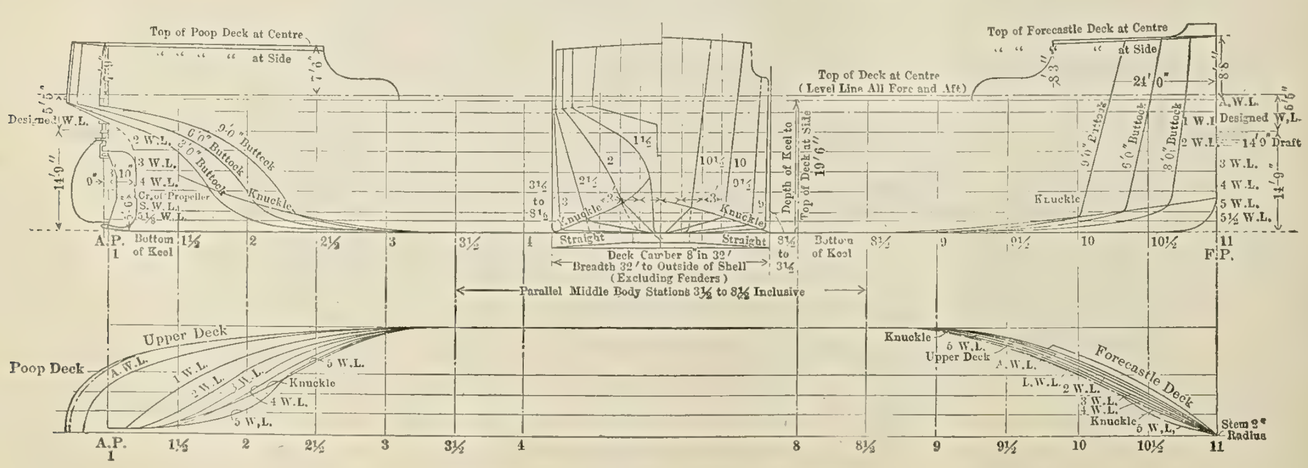


Fig. 3.—Lines of Ferro Concrete Cargo Boat

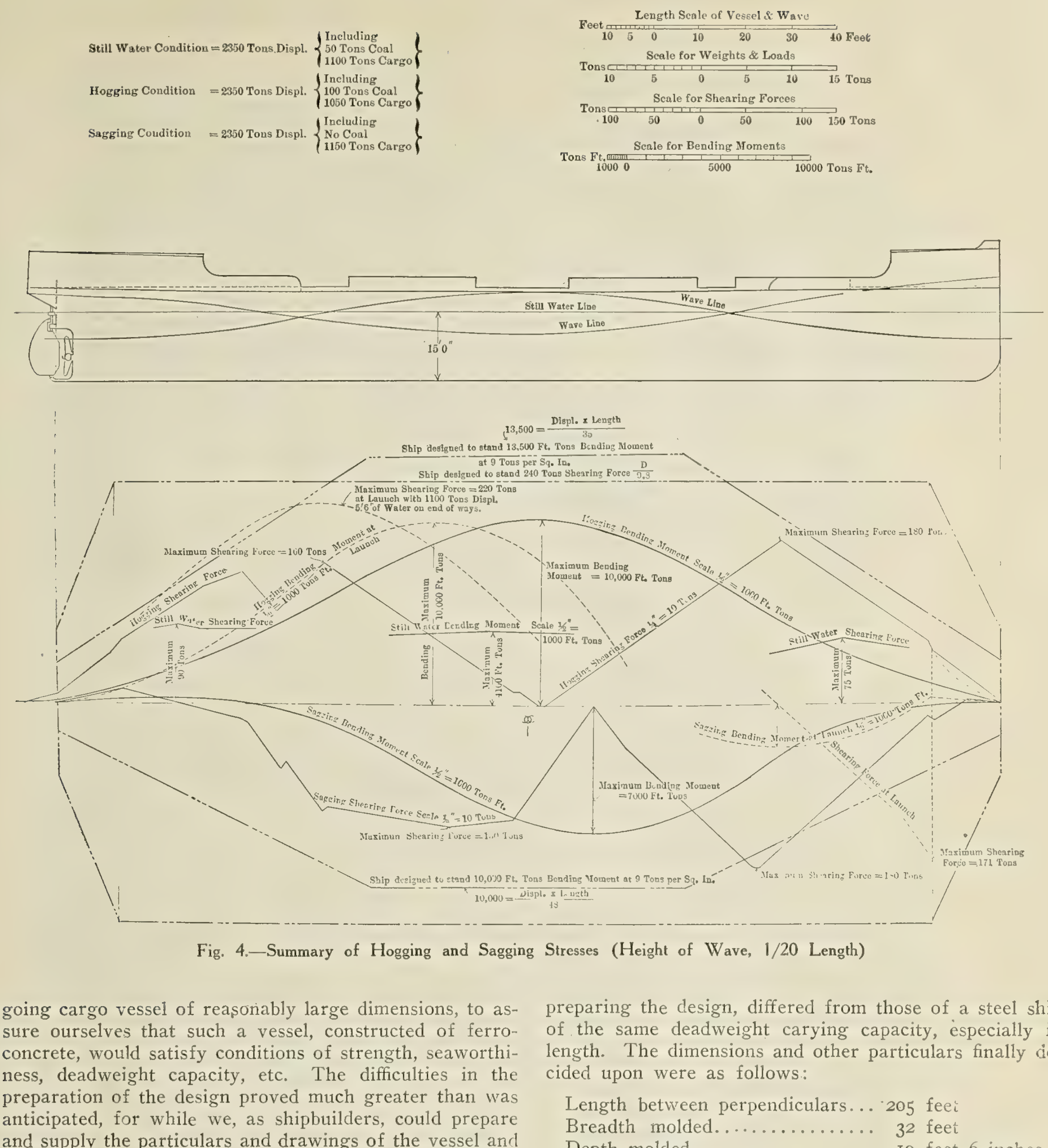


Fig. 4.—Summary of Hogging and Sagging Stresses (Height of Wave, 1/20 Length)

going cargo vessel of reasonably large dimensions, to assure ourselves that such a vessel, constructed of ferro-concrete, would satisfy conditions of strength, seaworthiness, deadweight capacity, etc. The difficulties in the preparation of the design proved much greater than was anticipated, for while we, as shipbuilders, could prepare and supply the particulars and drawings of the vessel and approximate to the maximum stresses coming on the various members, we had no practical experience of the construction of the ferro-concrete part of the hull, so that it became necessary to work in conjunction with a reliable firm of ferro-concrete engineers, who would carry out this part of the design, basing it on work actually done. This association of shipbuilders and ferroconcrete engineers has proved mutually satisfactory and advantageous, and each party found that it had something to learn from the other with respect to shipbuilding of this type.

It was eventually decided that a self-propelled cargo vessel of about 1,150 tons deadweight was as large as we were justified in commencing as a first venture. It was agreed that the vessel should comply with all the requirements obtaining for steel vessels, and the general scheme was based upon that of a similar ship constructed of steel. The dimensions, for reasons which occurred in preparing the design, differed from those of a steel ship of the same deadweight carying capacity, especially in length. The dimensions and other particulars finally decided upon were as follows:

Length between perpendiculars...	205 feet
Breadth molded.................	32 feet
Depth molded...................	19 feet 6 inches
Draft, when loaded.............	15 feet 6 inches
Indicated horsepower (about)....	400
Speed (about)..................	7¾ knots

The following drawings indicate the general arrangement and other features of the vessel:

Fig. 1.—General Arrangement Plan.

Fig. 2.—Midship Section.

Fig. 3.—Sheer Draft or Lines Plan of the Vessel.

The various arrangement drawings were prepared and scantlings arranged in accordance with Lloyd's Rules for Steel Ships. Using these scantlings, a list was made up of the calculated section moduli of the various members. Upon these particulars the engineers prepared constructional sections, on the Hennebique principle of "equivalent strength," which were adopted as a basis for calculation of weights, etc.

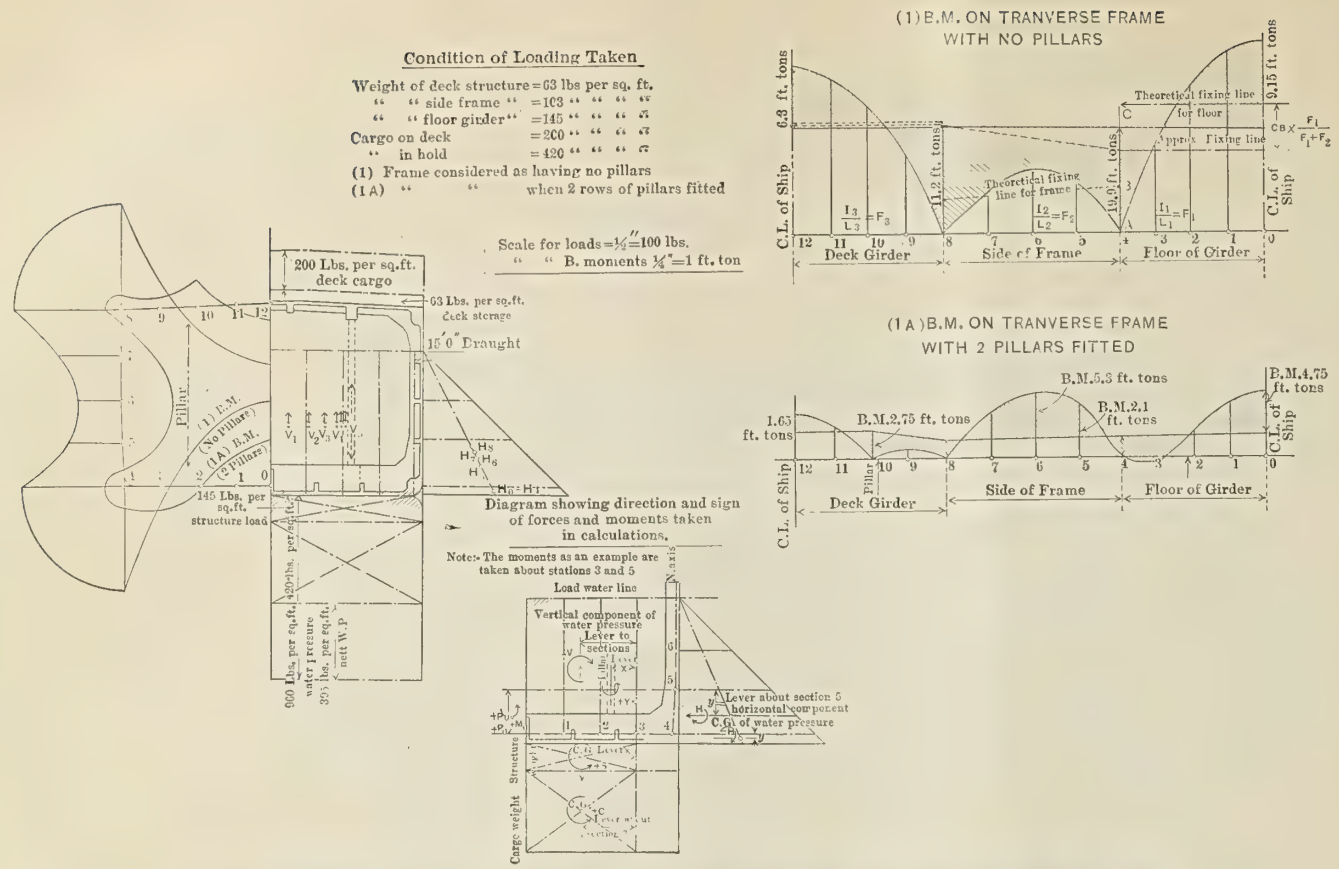


Fig. 5.—Transverse B. M. on Floor Girder, Side Frame and Deck Girder per Foot Length of Ship

The design was then carefully reconsidered and calculations made as far as possible for the stresses which the vessel would be subjected to, both longitudinally and transversely, under all reasonable conditions of construction, launching, and service.

One of the first things observed in the case of the ferro-concrete hull was that the center of gravity of the structural material worked out much lower than in the case of a steel hull, the result being a greater metacentric height than was desirable. To minimize this, the original beam of 34 feet was reduced to 32 feet, and in order to obtain the same hold capacity the depth was increased from the original 17 feet 6 inches to 19 feet 6 inches, fortunately, from the point of view of longitudinal strength, a modification in the right direction.

Lonitudinal Strength

In calculating longitudinal stresses the vessel was first of all assumed to be in still water with the holds loaded uniformly to the full-load condition, giving a dispacement of 2,350 tons. In this condition the maximum bending moment worked out at about 4,100 foot-tons. For hogging stresses the vessel was taken as being in the same load condition and on the crest of a trochoidal wave of length equal to the length between perpendiculars of vessel, and height equal to $\frac{\text{Length}}{20}$, giving a maximum shearing force of 180 tons and a maximum bending moment of 10,000 foot-tons.

In the sagging condition the vessel was much more severely loaded, three-fifths of the cargo being placed in the middle of the hold space, and one-fifth at each end respectively, resulting in a maximum shearing force of 180 tons and a maximum bending moment of 7,000 foot-tons.

In the case of launching, the maximum shearing force reached as high as 220 tons, with a maximum bending moment of 10,000 foot-tons. A generous margin was allowed over these figures, and the vessel was designed to stand the stresses corresponding to the following:

$$\text{Hogging moment, } \frac{\text{Displacement} \times \text{length}}{35} = 13{,}500 \text{ foot-tons}$$

$$\text{Sagging moment, } \frac{\text{Displacement} \times \text{length}}{48} = 10{,}000 \text{ foot-tons}$$

$$\text{Shearing force, } \frac{\text{Displacement}}{9.8} = 240 \text{ tons,}$$

the structural material being arranged so that the tensile stress on the reinforcement, taking account of all local stresses, never exceeded 9 tons per square inch, and the maximum compressive stress on the concrete 750 pounds per square inch.

Fig. 4 shows the longitudinal bending moment curves of the vessel in the various conditions.

Transverse Strength

In calculating transverse strength, the transverse framing was analyzed in order to ascertain the maximum bending moment to be resisted by the floors, frames, and beams under the various systems of loading to be met with in service.

The conditions assumed, for which calculations were made, are as follows:

(1) Vessel, without pillars, loaded to deep draft in still water. Cargo load in hold and on deck (see Fig. 5).

(1*a*) Vessel, with two pillars fitted, one at each side of hatch opening, loaded to deep draft in still water as in condition (1) (see Fig. 5).

(2) Vessel, with two pillars fitted, loaded as in (1),

and situated on wave crest, with no cargo on floor girder (see Fig. 6).

(3) Vessel, with two pillars fitted, loaded and situated in wave hollow with full cargo, load centrally placed below hatches and no deck cargo.

(4) Vessel, with two pillars fitted, in light condition, in dry dock, docked on center keel.

The calculations were investigated on the "principle of least work," taking the reinforced framing as monolithic.

In the moment as calculated there has been taken into account the stresses in the framing where only a partial support is received from the pillaring through the medium of longitudinal girders spanning between the transverse frames. The scantlings of the framing have been proportioned to the more severe conditions met with at the center of floor girders, bilge, side frame, deck corner, and beam.

It may be observed that if the floor girder is designed to resist the bending moment in condition (2), it is also strong enough to meet the docking condition in condition (4), where the bending moment is about two-thirds that of condition (2). In condition (3) the bending moment is reversed in direction and the floor tends to deflect downwards, caused by a bending moment approximately two-thirds of that causing the upward deflection in condition (2).

To provide an estimate of the bending moment to be allowed for in the first instance, the framing was treated as a continuous girder, and the free bending moment calculated for the several spans.

These were plotted on a straight base representing the neutral axis of the framing and the theoretical fixing moment lines drawn; at the points of junction between the floors, frames—where the amounts of the fixing moments varied—and beams, the difference in bending moment was proportioned to the expression $\frac{I}{L}$ of the member on each side of the joint.

Diagram 2 on Fig. 6 indicates the bending moments as estimated by the approximate method for condition (2).

Basis for Strength Calculations

As a basis for calculation of strength, the following were adopted as working limits for safe stresses on concrete and steel:

Concrete

Item.	Working Stress, Pounds per Square In.	Ultimate Stress, Pounds per Square In.
Compression in beams	750	4,000
Compression direct	700	4,000
Shear	70	280
Adhesion	60	240
	100	500

Steel

Item.	Working Stress.	Elastic Limit.	Ultimate Stress.
Tension, spiral bars	9 tons, square in.	23½ tons, sqaure in.	30–36 tons
Tension, plain bars	7½ " " "	15 " "	27–30 "
Compression	7½ " " "	15 " "	27–30 "
Shear	5½ " " "		24 tons

The vessels are, as before stated, in course of construction at Barrow-in-Furness, and the sand and aggregate found locally have proved most satisfactory for a concrete mixture suitable for shipbuilding. The concrete adopted is formed of a rich mixture of 1 part cement, 1.2 parts sand, and 2.4 parts granite aggregate (by volume). The cement used weighs 84 pounds per cubic foot. The sand used is of a coarse nature, having the following sieve test:

Mesh of Sieve	Remaining Percentage on Sieve
100 × 100 per inch	100 percent
50 × 50 "	61 "
20 × 20 "	14 "

The agregate used consists of granite chippings from ⅝ inch downwards, weighing 92.5 pounds per cubic foot. The proportionate amounts of cement, sand, and aggregate to form 27 cubic feet or 1 cubic yard of concrete are:

9 cubic feet cement, 10.74 cubic feet sand, 21.47 cubic feet aggregate = 1 cubic yard.
= 757 pounds cement + 1,192 pounds sand + 1,986 pounds aggregate = 3,935 pounds.
= .34 ton cement + .53 ton sand + .89 ton aggregate = 1.76 tons
Add to this .05 ton water = 1.81 tons per cubic yard of concrete.

For estimating purposes 1 ton of concrete contains .57 cubic yard = 15.4 cubic feet; or .192 ton cement, .300 ton sand, and .508 ton granite.

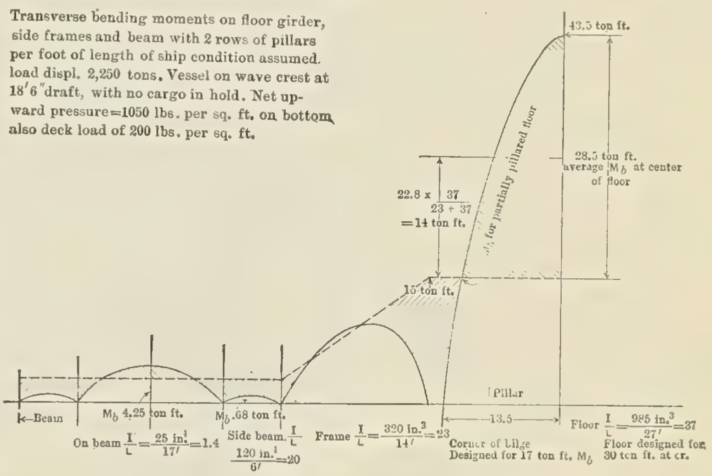


DIAGRAM (2)
DIAGRAM OF BENDING MOMENTS & LOADS ON TRANSVERSE SECTION FOR 1 FOOT LENGTH OF SHIP

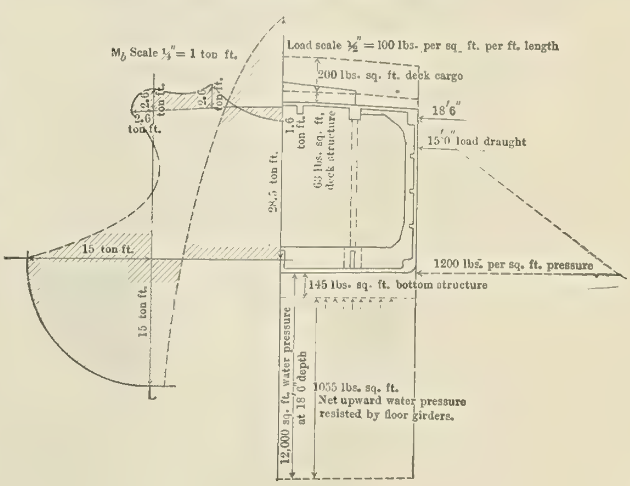


Fig. 6

Machine mixing of concrete is preferable to hand mixing, inasmuch as a standard and invariable mixture may be obtained, due to the use of auotmatic devices for the

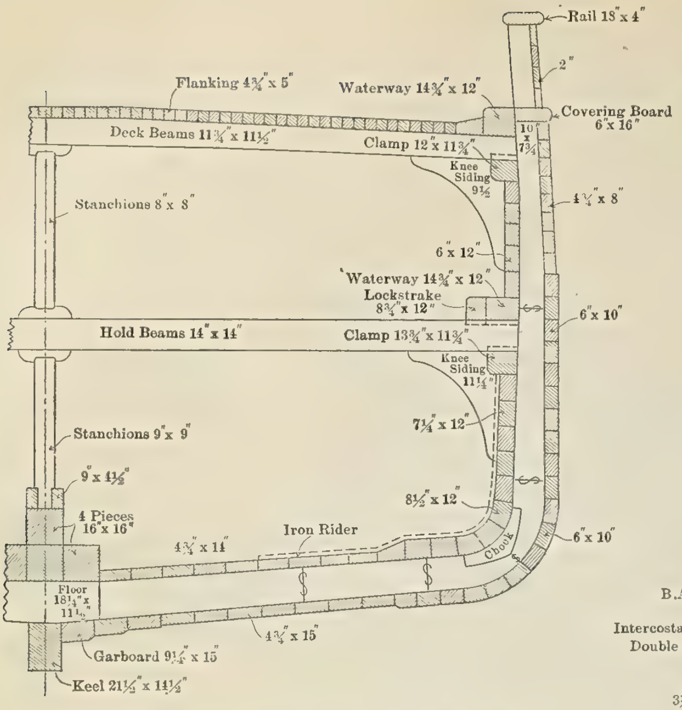


Fig. 7.—Wooden Cargo Vessel (1,150 Tons Deadweight), 205 Feet (B. P.) by 36 Feet by 18 Feet 9 Inches and 2,400 Tons Load Displacement. Midship Section Showing Scantlings for Spruce

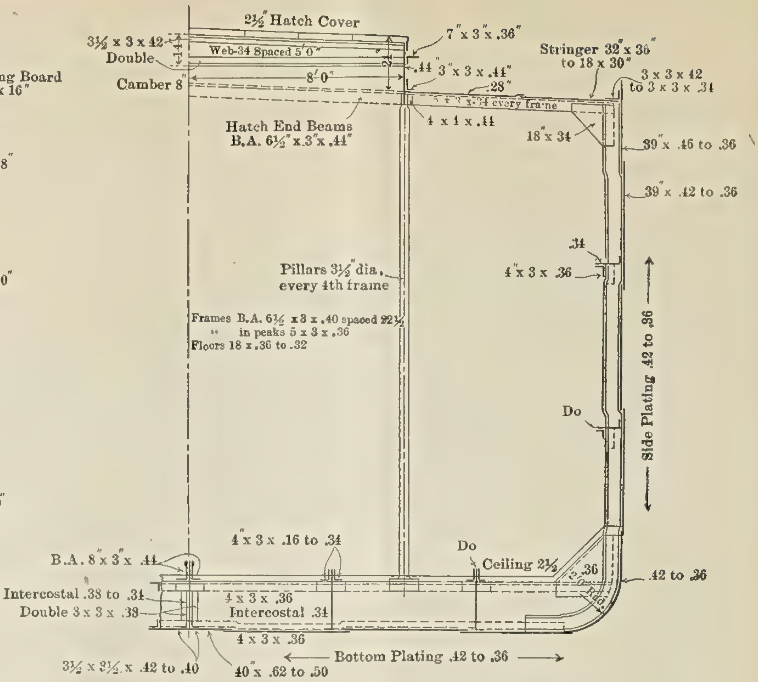


Fig. 8.—Cargo Steamer (1,150 Tons Deadweight), 188 Feet by 30 Feet 3 Inches by 17 Feet 3 Inches, Molded, Load Displacement 1,800 Tons. Midship Section

measurement of the various ingredients as well as of measurement of the time of mixing.

Particulars and Description of Hull

There are shown in Figs. 2, 7 and 8 three midship sections respectively for the ferro-concrete, a steel and a wooden ship, each designed for a deadweight carrying capacity of 1,150 tons. The particulars of the three ships are as follows.

	Reinforced Concrete.	Steel.	Wood.
Length	205 feet 0 inches	188 feet 0 inches	205 feet 0 inches
Breadth	32 " 0 "	30 " 3 "	36 " 0 "
Depth	19 " 6 "	17 " 3 "	18 " 9 "
Draft	15 " 6 "	14 " 6 "	*16 " 6 "
Deadweight	1,150 tons	1,150 tons	1,150 tons
Displacement (load)	2,350 "	1,800 "	2,400 "
Ind. horsepower (about)	400	400	400

	Weights.		
	Reinforced Concrete.	Steel.	Wood.
Steel in hull†	190 tons	445 tons	140 tons
Remainder of hull	860 "	80 "	960 "
Machinery and boilers	80 "	80 "	80 "
Outfit‡	70 "	45 "	70 "
Deadweight	1,150 "	1,150 "	1,150 "
Load displacement	2,350 tons	1,800 tons	2,400 tons

* Includes 12-inch wood keel.
† Includes hull castings and forgings.
‡ Includes anchors, cables, boats, auxiliary machinery, etc.

It will be noticed that the weight of steel in the ferro-concrete ship is about 42½ percent of that in the steel ship. This is not by any means such a large reduction as some writers on ferro-concrete ship construction have anticipated, nor is it probably the minimum quantity which we could have adopted had we been prepared to incur a certain amount of risk in structural strength. In view, however, of this being our first venture in a new method of construction, we did not feel justified in reducing the strength until we had ascertained from experience how a ship constructed on this principle would act under ordinary conditions of service. One reason was that, should the vessel prove weak, it would be a matter of the utmost difficulty to introduce additional stiffening and strength. A second and even more potent reason was that we were not justified in risking the safety of the ship or the lives of the men who might navigate her, for the purpose of endeavoring in the first ship to reduce the quantity of steel that might be used to the minimum. Actual service will perhaps give an indication where weight may be saved, either in the steel or concrete of the hull; and that such saving will ultimately be effected, even with identical methods of construction, we confidently anticipate. It must not be overlooked that the saving of steel effected, especially under present conditions, is of the greatest importance. If we take, say, 200 vessels similar to the one under discussion, we should have an additional carrying capacity of 230,000 tons added to our mercantile fleet, while there would be a total saving of 51,000 tons of steel as compared with a similar number of steel ships of equal carrying capacity. Moreover, this steel is worked in the form of reinforcement rods and is not dependent upon the plate rolling mills for its production. This is the more important as at the present moment it is largely the limited output of the rolling mills which adds to the difficulty of procuring an adequate amount of shipbuilding steel.

We came to the conclusion that the most economical as well as the most efficient rod for ship construction was that known as the spiral bond bar. This is an ordinary mild steel bar, which subsequent to being rolled is stressed by being twisted in such a manner that the elastic limit is raised about 35 percent, the twist in the bar giving at the same time a continuous mechanical bond with the concrete in which it is embedded. With this high elastic limit smaller sections may be employed than would be possible with an ordinary mild steel bar, which means a

reduction in weight of steel used. As the continuous mechanical bond justifies shorter overlapping of bars at junctions, the weight of steel is again reduced. A further advantage of the special twisting treatment lies in the fact that steel of very low tensile strength may be thus treated, and so release for other important work the higher quality steel.

The following is a table of actual tests of a spiral bond bar (1⅜ inches diameter) before and after twisting:

Original Size.		Contraction of Area.			Elongation in 8 Inches.		Ultimate Stress.		Elastic Limits.	
Diameter.	Area.	Diameter.	Area.	Percent.	Inches.	Percent.	Actual Tons.	Tons Per Square In.	Actual Tons.	Tons Per Square In.
Before twisting, 1.375 ins...	1.39	.88	.568	59.2	10.40	30.0	37.4	26.9	24.5	17.62
After twisting, 1.375 ins....	1.39	.89	.581	58.2	9.68	21.0	41.3	29.7	33.2	23.86

See stress strain diagram, Fig. 9

Although the structure of these vessels, both in relation to the shell and frames, is purely reinforced concrete throughout, the possibility of working the shell of ferro-concrete vessels in conjunction with ordinary frame bars or built-up frames has not been lost sight of, although the problems attendant on such a departure from a purely monolithic structure present difficulties. It is conceivable that a vessel might be satisfactorily constructed in which the ordinary steel frame is used in conjunction with the present system of reinforced concrete hull, and in the United States they appear to have adopted some such method. With our present knowledge there would appear to be in this connection an element of danger unless a system is used blending together the parts in such a way as to leave no possible chance of disruption. The experience gained by American builders in this respect may help to solve this difficulty, as the principle, if successful, appears to be well worthy of adoption. It may indeed be essential in ferro-concrete ships of large tonnage. Such a system, too, would overcome some of the difficulties in connection with the fitting of various details which, at present, it is necessary to arrange before the concrete portion is commenced. A further advantage, and probably the principal one, is that, without having to introduce a much greater proportion of skilled labor, the system would result in a decreased weight of hull.

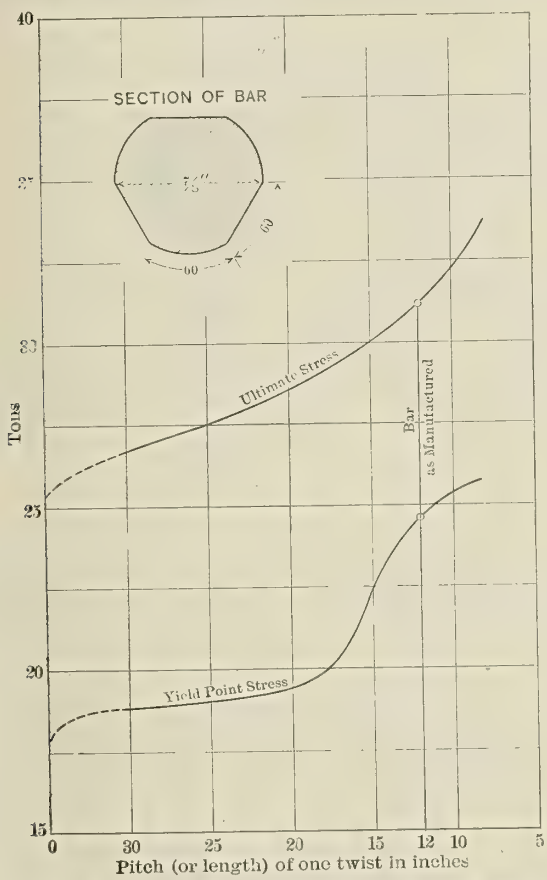


Fig. 9.—Curves Showing Comparison Between Rates of Increase of Yield Stress and Ultimate Stress for ⅞-Inch Diameter Bar, by Actual Test, of Pieces Cut from Same Bar but with Different Length of Twist

Hull Fittings and their Connection

Many problems have arisen regarding fittings and their connection and relation to the ship, which in ordinary steel construction are simple, but which, in the case of ferro-concrete construction, offer difficulties which have had to be carefully examined and overcome. Among these are the openings in the ship's bottom, stuffing-boxes, the passage of pipes through bulkheads, the connection of fittings to the bulkheads, and the connection of stanchions, fairleads, bollards, etc., to the deck. Added to these are important problems, such as the connection to the hull of

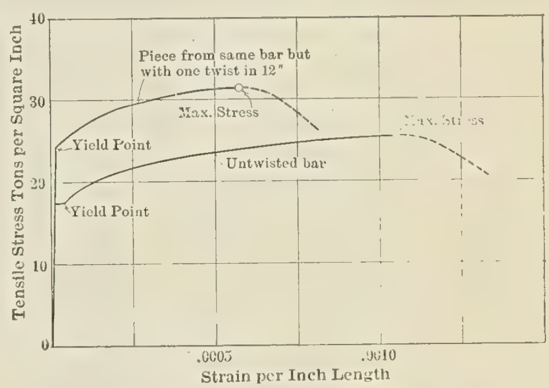


Fig. 9a.—Stress-Strain Diagram for ⅞-Inch Diameter Bar, Before and After Twisting, Showing Respective Yield Points, Maximum Stress and Strain

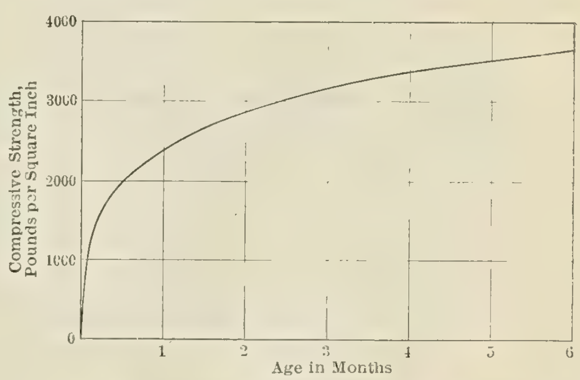


Fig. 10.—Diagram Showing Increase of Strength of Concrete with Age. Mixture (by Volume) of Concrete Used: Cement, 1.0; Sand, 1.2; Aggregate, 2.4

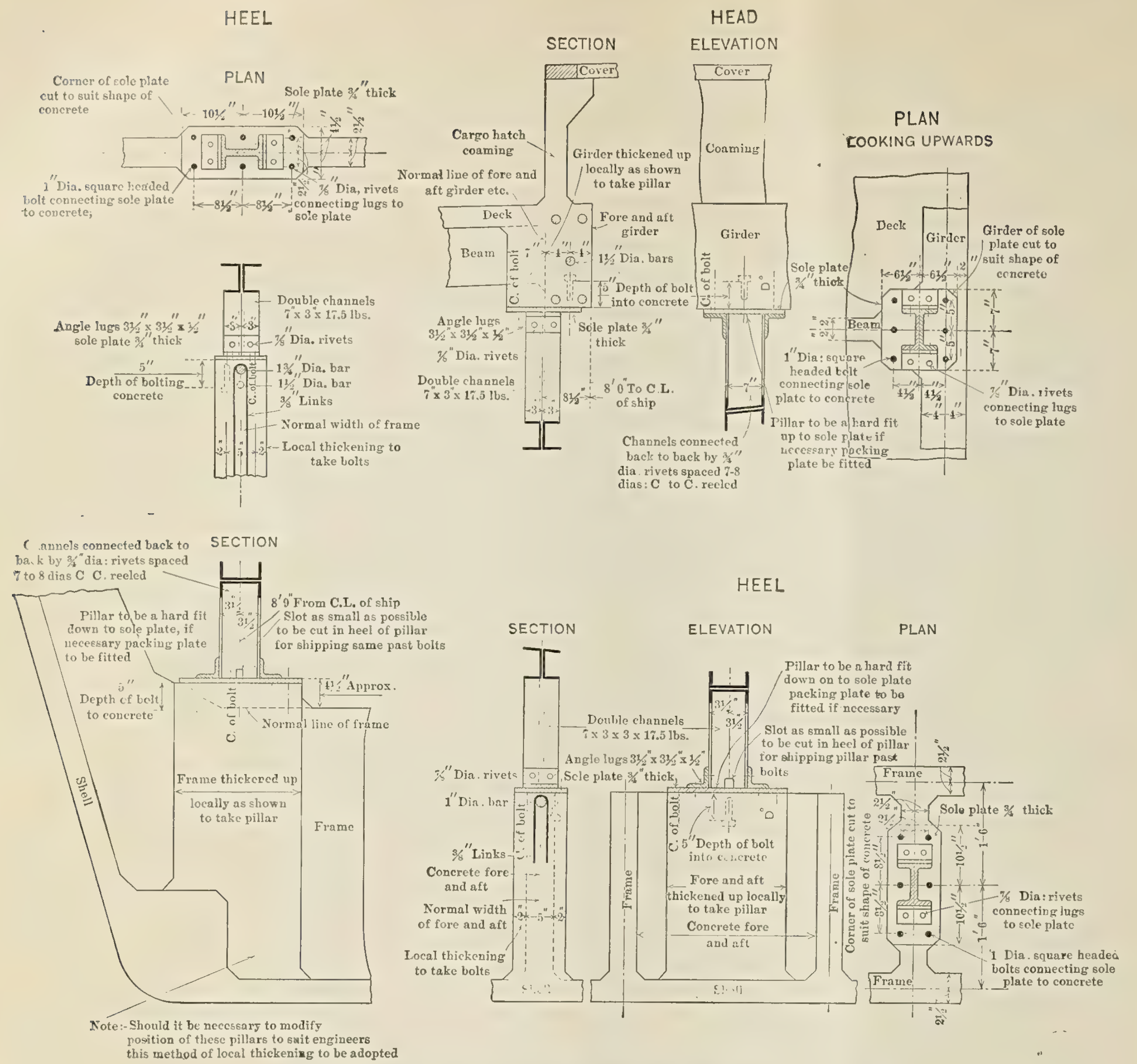


Fig. 11.—Detail of Heads and Heels of Pillars

the rudder post, stern post, and the stern tube. In order to illustrate some of the difficulties experienced and some of the means adopted to overcome these difficulties, I have appended to this paper some sketches showing how certain of these questions have been dealt with, such as, for instance: Fig. 11—Arrangement of Pillaring. Fig. 12—Typical Spigot for Sea Connections. Fig. 13—Ceiling Plan.

There is no doubt that, with experience, improved methods of adapting fittings and parts of the structure to their proper functions in economical and efficient manner

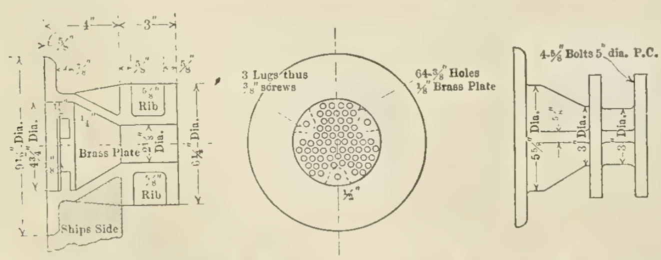


Fig. 12.—Typical Suction Connection on Ship's Side

will be evolved, but for the moment we think that the methods adopted, as illustrated in the drawings reproduced, are such as to give reasonable justification for anticipating efficient performance. In the case of a steel ship, if before the erection of the bulkhead provision has not been made and holes punched to take any particular fitting, as, for instance, a bracket, it is an easy matter to drill such holes afterwards to accommodate it. For a concrete vessel, however, the cutting of holes after the concrete has set is not easy and is undesirable. It is, therefore, highly important that all the details of fittings required to be connected to the hull, or passing through a bulkhead, for instance, should be considered before the erection and casting of that bulkhead, and the necessary information must be ready at an early stage of the construction in order that the builders may make suitable provision for the same when erecting the shuttering. Where it is necessary to leave a hole in the concrete, a wooden peg may be fastened to the shuttering in the required position; but in the case of pipes passing through a deck or a bulkhead, a better arrangement is to cast a metal spigot in the concrete with

suitable flanges or screwed ends projecting on each side for connection to the pipes. Such fittings as mooring pipes or hawse pipes, as well as the majority of small topside fittings, have to be specially designed, with proper projections, for casting into the concrete, as otherwise holes must be prepared to take the holding-down bolts.

Lines and Tank Trials

It is obvious, in view of the fact that the whole of the vessel's hull has to be cast in molds or shutters, that the simpler and straighter the lines of the vessels the more cheaply and easily the shuttering can be constructed, and the more rapidly the work can be proceeded with. For this reason, when designing the lines, a simple midship section was adopted having a perfectly straight side and bottom with only a very small curvature at the bilge. This section was retained in a parallel middle body for half the length of the vessel amidships, and the waterlines forward rounded into an easy entrance, still retaining, however, the straight-line sections. In rounding in the waterlines aft the straight-line sections were retained as far as possible and then run aft to the propeller and faired in with a minimum of curvature.

In determining the form two points had to be considered:

(1) That the fullness of form which is economical in ordinary cargo boats when coupled with moderately low speeds would certainly be desirable when the material of construction was such that the weight of hull accounted for a larger proportion of the displacement than in the case of a steel ship.

(2) That the introduction of straight lines in the transverse sections, while desirable for constructional purposes, might lead to a large increase in resistance compared with an ordinary cargo boat form, if there were any tendency for the stream lines to flow across the knuckle (i. e., the intersection of the two surfaces forming the sides and bottom).

To obtain a reasonably good form under the above conditions, trials were carried out in the experimental tank as follows: The model was made fuller than was actually required and cast thick enough locally to allow cutting off at certain parts. After the curve of resistance had been obtained with the original model (C S), Fig. 14, the bottom part of the bow was fined (C S_2) with improved

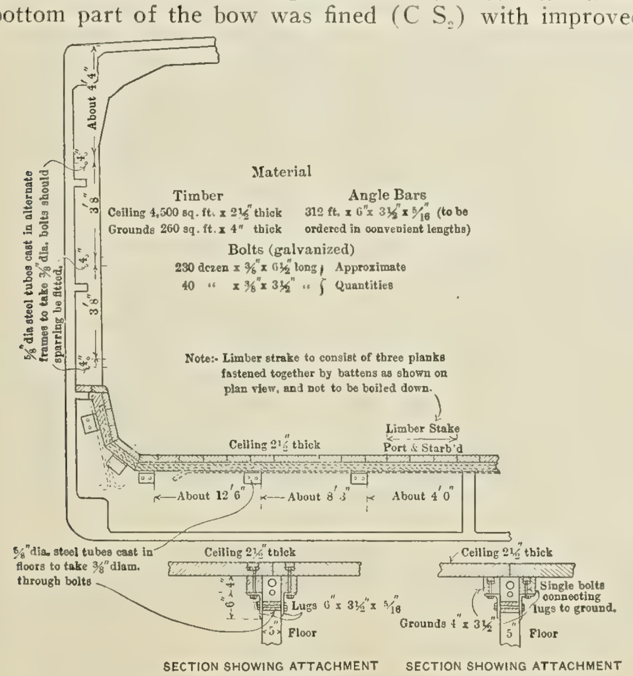


Fig. 13.—Arrangement of Ceiling

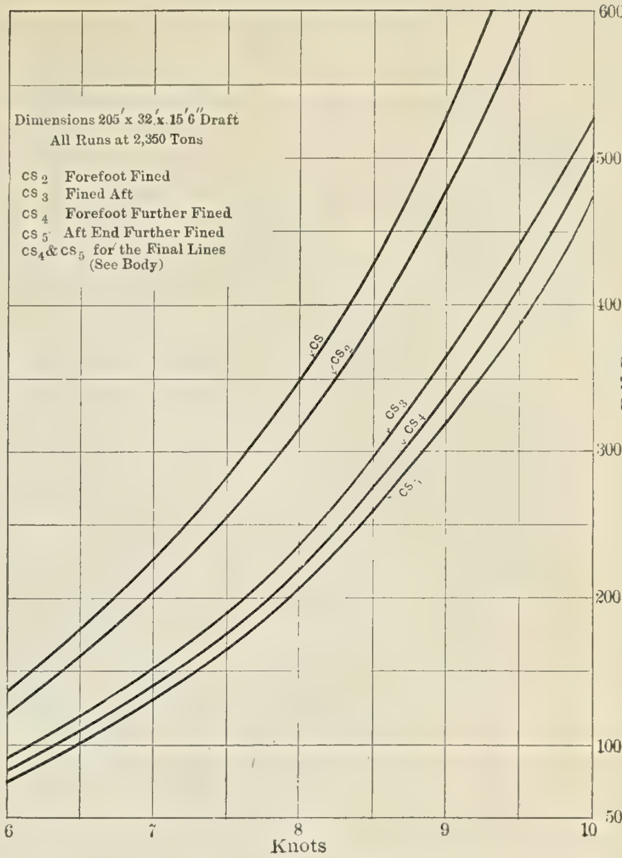


Fig. 14.—Tank Results. Model "C S" (Concrete Ship)

result. Then the after-body was similarly fined (C S_3) with further advantage. A further fining of the bow (C S_4) and then again of the stern (C S_5) still improved the form, which was now reasonably comparable with an ordinary cargo boat form of the same dimensions and displacement.

The total modifications made were comparatively slight, amounting to 23 tons, and reducing the block coefficient by .01.

The load waterline and curve of areas have generally been regarded as the determining features of the resistance of an ordinary form, but we found that the influence of the knuckle was so marked that, with the waterline unaltered and practically the same curve of areas, a reduction was made in resistance of 40 percent.

The lines plan, Fig. 3, shows in dotted lines the model as originally tried corresponding to the C S form on the tank results diagram, Fig. 14, and the full lines on the lines plan show the lines to which the ship is actually being built and correspond to the last trial in the tank and to the C S_5 form on the tank results diagram. It was not considered necessary to show the intermediate modifications on the lines plan.

The lines ultimately adopted may, therefore, very reasonably be considered as the most suitable for simplicity of shuttering and for easy construction in ferro-concrete.

The deck has a chamber of 8 inches in the full breadth; but here again curvature has been avoided, the crown being a level flat 4 feet each side of the center line, the remaining deck sloping in a straight line to the side, as shown on the lines plan, Fig. 3, and the deck at center is a straight line all fore and aft.

Propelling Machinery and Boilers

With respect to the propelling machinery, the considerations which have to be taken into account as to suitability of type are practically the same in ferro-concrete

as in steel ships; but the method of efficiently connecting the machinery to the hull of the ship, the arrangement of the stern tubes, the special attachment to the shell of sea connections, etc., require more consideration in the former case, and great care has to be taken to ensure reliability in this respect.

In the present six boats building to this design the adoption of machinery has been largely governed by what it has been possible to obtain under existing circumstances.

In three of the vessels we are fitting compound surface condensing single screw engines of approximately 350-400 horsepower with cylinders 17 inches and 34 inches diameter, 24-inch stroke, working at about 100 revolutions per minute.

The boiler installation consists of two cylindrical boilers 9 feet 6 inches diameter by 9 feet long, working at a pressure of about 130 pounds.

In the remaining three we intend fitting triple expansion engines of about 500 indicated horsepower, which will somewhat reduce our deadweight capacity but give an appreciable increase of speed.

Two boilers were decided upon, so that in the case of a breakdown of one there would be sufficient boiler power in the ship to drive the vessel at a reasonable speed. When in port one of the boilers will be of sufficient power to work all necessary auxiliary machinery, including that for loading or discharging. Incidentally, there are other advantages in having two small boilers, such as the possibility of their transport by rail instead of by sea from the place of manufacture to wherever the machinery is being installed. Further, the advantage of being able to ship the boilers through the hatchways, as leaving any part of the deck unfinished for this purpose, is very undesirable in ferro-concrete ships.

The machinery is fitted aft, a usual position in this type of cargo vessel; but another reason for this was to reduce the length of tunnel, as if this were of ferro-concrete instead of steel it would form an important item of weight.

Launching

Coming next to the question of launching, this is an operation which, in the case of ferro-concrete ships, requires more than ordinary consideration and care. This operation, always fraught with anxiety, is doubly so when dealing with a vessel of ferro-concrete construction. Take, for instance, the launching arrangements for the vessel under discussion. A launching weight of 1,100 tons has to be dealt with as compared with about 550 tons in the case of a steel ship of corresponding size. To keep down the stresses, a moderate declivity of ways with ample depth of water on the way ends has been arranged; but, even so, quite a considerable hogging stress and excessive way-end pressures are met with just before the stern commences to lift. Some internal shoring has to be arranged at suitable parts of the vessel as additional precautions before launching. The shearing forces at the fore poppet are severe and must be met by an adequate strength of hull.

The foundation supports, especially as the vessel is being built on new ground, have been carefully considered, as sinkage during any stage of the concreting would have serious results and must be guarded against.

The precaution of allowing the concrete sufficient time to set properly before the vessel is launched is necessary in view of the fact that the compressive strength of the concrete continues to increase for some time after being worked, and it is necessary to utilize as much of this increased strength as possible to resist the launching stresses. Fig. 10 shows this increase of compressive strength on a base of months.

The supporting blocks and holding-up arrangements (dog shores) also require greater strength than is necessary in the case of the lighter steel vessels. A sketch showing the arrangements made is given on Fig. 15, and shows very fully the practical arrangements as well as the curves of stresses under all conditions likely to be met with.

Generally speaking, the severe launching conditions may be taken as an adequate test of the vessel's ability to withstand any stresses she may be called upon to meet under ordinary conditions of service.

To obviate the undesirable necessity of pile-driving in the channel where the vessel is being built, the standing ways beyond the sea-wall are supported on specially designed pontoons resting on the bed of the channel. These pontoons are specially constructed of concrete and may be towed from one berth to another, and when in the necessary positions are sunk by being flooded through sluice valves arranged in the sides for that purpose (see Fig. 15).

Some statement should perhaps be made here as to the time for construction of vessels of this type as compared with steel ships, and our experience so far leads us to believe that in the case of the first vessel of any type, the time of construction approximates very closely to that of a steel ship, but that in building successive ships of the same size and form there will be a marked reduction owing to the possibility of using repeatedly a large proportion of the shuttering or molds. By this means I believe that, with all the material to hand, a vessel similar to that described in this paper could be completed in three and a half to four months.

I regret that neither time nor space allows me to indicate other types under construction in the yard, all possessing interesting characteristics. When completed their performances will no doubt add a helpful contribution to the study of ferro-concrete construction as applied to shipbuilding. Neither can I touch on the question of the application of discard steel for constructional purposes, as largely advocated by some builders, nor on the future possibilities of ferro-concrete as applied to shipbuilding when the time arrives when we shall not be driven to its adoption by stress of war conditions.

I admit some limitations in the paper, due to absence of precise knowledge and experience of the sea tests of the ships, but I hope to have the honor on another occasion of completing this contribution by giving the service results of the vessels described, when opportunity will probably occur to deal with other points omitted from the present paper.

In conclusion, I should like to express a word of thanks to those associated with me in this work: the members of the staff of the Ferro-Concrete Ship Construction Company, of Barrow-in-Furness, who have worked so energetically and untiringly in the design and construction of the vessels; and to the directors and staff of Messrs. L. G. Mouchel & Partners, who have brought great ability and experience to bear on the solution of some of the difficult problems involved; also to the directors of the Yorkshire Hennebique Company, who have by their experience shown us how, in many ways, the time of construction can be shortened.

A boiler is a means for converting latent energy into dynamic force. The quicker this can be done the more economical is the boiler.

If you have work to do in meters, centimeters and millimeters, forget that there are such measurements as yards, feet and inches. It will save you brain fag.

Supplem

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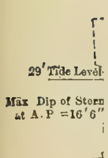

29' Tide Level
Max Dip of Stern
at A.P =16'6"


MIDS
Weight 5 Tons
Pressure on G
1½ tons per sq
Pressure on Lu
sq. ft
erro Concrete Bloc
4'6"Apart

REINFORCED CONCRETE CARGO STEAMERS BUILDING IN GREAT BRITAIN

(From Paper by T. G. Owens Thurston before Institution of Naval Architects)

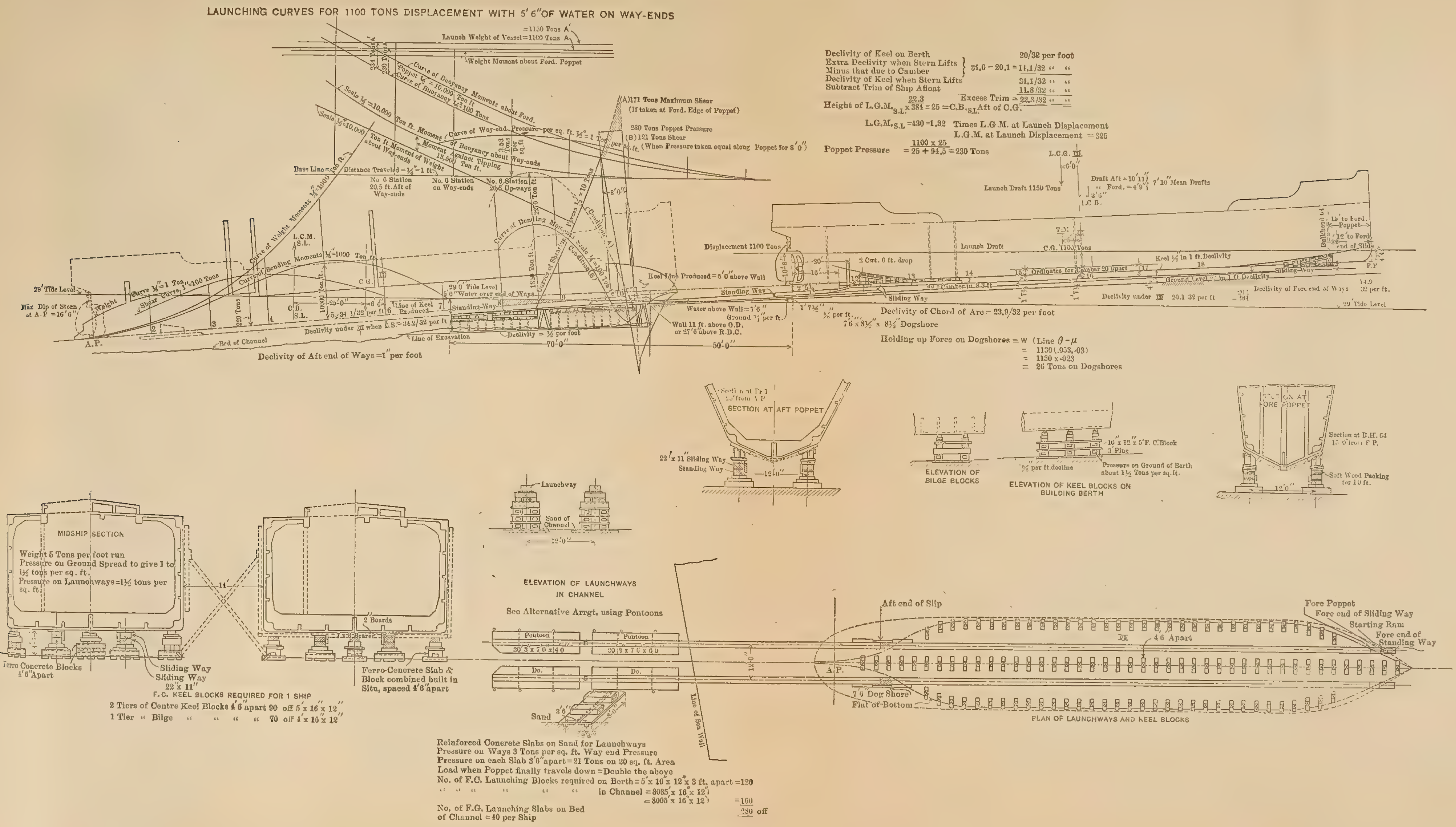


Fig. 15.—Launching and Berthing Plan

Length of standing ways, 313 feet by 6 feet; camber in 313 feet 22 inches; length and breadth of sliding ways, 164 feet by 22 inches; area of sliding ways, 600 square feet; launch displacement, 1,100 tons; weight on standing ways, 1,130 tons; pressure per square foot on ways, 1.88 tons per square foot; center of gravity aft of midship section, 6.5 feet; poppet pressure, 230 tons; moment against tipping, 13,500 tons; bending moment on overhanging stern, 10,000 foot tons; stress on concrete, 350 pounds per square inch; tensile stress on reinforcement, 5½ tons per square inch; minimum water on ways ends, 5 feet 6 inches.

Program of Power Plant Saving

STATE Administrative Engineers of the United States Fuel Administration held a conference in Washington on June 28 and 29, discussing the plan of organization in connection with conservation of fuel in power plants throughout the United States. The engineers appointed to date are:

Thomas R. Brown, Pittsburgh, for western half of Pennsylvania; formerly special engineer of Westinghouse Air Brake Company.

George R. Henderson, Philadelphia, for eastern half of Pennsylvania; formerly consulting engineer of Baldwin Locomotive Works.

Edward N. Trump, New York City, for state of New York; vice-president of Solvay Process Company.

W. R. C. Corson, Hartford, for New England; secretary, Hartford Steam Boiler Insurance Company.

Charles A. Cahill, Milwaukee, for Wisconsin.

Others at the conference were: M. S. Hopkins, Columbus, Ohio; O. P. Hood, Bureau of Mines, Pittsburgh; Prof. L. P. Breckenridge, Yale University; H. H. Stoek, University of Illinois.

The national programme will extend into all states east of the Mississippi, and include Louisiana, Missouri, and Minnesota. An administrative engineer will be appointed for each of the states in the area mentioned.

This plan is the result of conferences with the Federal Administrators and their committees for the group of states which together consume about seventy percent of all coal used in the United States, exclusive of railroads. The plan has received the endorsement of all of these states, as well as approval by the United States Bureau of Mines and the Committee of Consulting Engineers on Conservation and Publicity, which represents the Engineering Council of the four National Engineering Societies.

Maximum Production With Minimum Waste

The slogan of the campaign is "Maximum production with minimum waste." The object is to operate all industries at full capacity, but to make every pound of fuel perform maximum service. In laying the foundations for the organization it has been anticipated that this work should become a permanent service of the Government.

Ten to twenty percent, that is, from twenty-five to fifty million tons of coal per year, can be saved by correct operation of steam power plants, using their present equipment, and without installation of new apparatus. It is considered most important that all existing fuel conservation committees, committees of Chambers of Commerce and National Defense, Manufacturers Associations and other bodies be continued in full force, and that the cooperation of such organizations be obtained.

The administrative engineer in each state will work under the supervision of the present Federal Administrator. No separate or new organization is contemplated, but sufficient addition to the working force in each state will be made to insure efficient execution of the new function.

The National plan comprises certain fundamentals, as follows:

1—Personal inspection of every power plant in the country.

2—Classification and rating of every power plant, based upon the thoroughness with which owner of said plant conforms to recommendations.

3—Responsibility of rating the plants will fall upon the Administrative Engineer in each state; the rating to be based upon reports of inspectors, who will not express opinions, but will collect definite information. The State Fuel Administrator in his judgment may entirely or partially shut off the supply of coal to any needlessly wasteful plant in his territory.

4—Inspectors are to be furnished from one or more of the following sources:

A—Inspectors of the steam boiler insurance companies.
B—State factory inspectors.
C—Engineering students from technical colleges.
D—Volunteers and others.

The ratings will be based upon recorded answers to questions, each of which will be given a value depending upon its relative importance to the other questions. Depending upon the efficiency of methods in use in any plant, it may be rated in Class 1, 2, 3 or 4.

The Administrative Engineer in each state will have supervision of electrical and mechanical problems connected with fuel conservation activities contemplated under this plan.

Basis of Power Plant Ratings

The ratings will be based upon existing equipment. The difficulty, delay and expense involved in the installation at this time of improved power equipment are fully recognized; but experience has proved that ten to twenty percent of fuel now used in power plants can be saved by improvements in operation alone.

In advance of the first inspection a questionnaire is being sent to every power plant in each district, with notice to the owner that within, say, sixty days his plant will be inspected personally, and the questionnaire will be checked up by the inspector upon his visit. This action will give a reasonable time to any plant owner to improve the operation of his plant and conform to recommendations before his plant is actually rated. Thus, when the inspector calls for the purpose of obtaining and checking up the information form, the plant may receive a much higher rating than would have been the case if no time were allowed between the sending and collecting of the questionnaire.

It is recommended that a board of competent engineers be attached to the conservation committee in each state; also a corps of lecturers to arouse public interest and disseminate engineering information.

The Fuel Administration has prepared a fifty-minute film of moving pictures showing good and bad operation in the steam boiler plant, methods of testing boilers, etc. These pictures will be available to each state in connection with its educational propaganda.

The Administration is also preparing a series of official bulletins on engineering phases of steam and fuel economics. Some of these are now ready for printing. They will include:

1—Boiler and Furnace Testing.
2—Flue Gas Analysis.
3—Saving Steam in Heating Systems.
4—Boiler Room Accounting Systems.
5—Saving Steam and Fuel in Industrial Plants.
6—Burning Fine Sizes of Anthracite.
7—Boiler Water Treatment.
8—Oil Burning.
9—Stoker Operation.

In addition to this service, a list has been prepared in Washington of competent engineers for each state and is available for use of each local Administration. As the work develops, still further constructive assistance is contemplated for helping owners to bring their plants up to a high plane of economic operation.

How Can Soft Coal Be Burned Without Smoke in Marine Boilers?

Mechanical Stoking and Use of Pulverized Coal Advocated by Mechanical Engineers for Reducing Smoke on Steamships

At the spring meeting of the American Society of Mechanical Engineers held at Worcester, Mass., June 4 to 7, sessions were held for the discussion of the subject of fuel economy, a subject of utmost importance this year as the country now faces a coal shortage of 80,000,000 tons. The question of how soft coal can be burned without smoke in marine boilers attracted considerable attention, as the avoidance of smoke on the transports and cargo vessels now carrying our troops and supplies to France would decrease the radius of visibility of these vessels by many miles and greatly reduce their liability to attack by submarines. If efficiency is thereby improved it means in this case much more than mere saving of coal.

Albert A. Cary, consulting engineer, New York, stated without qualification that the smoke nuisance can be overcome practically and satisfactorily without drastic changes from the present form of steam generating equipment. Two methods are available—either suppress the fires in the furnace by firing in such small quantities as to prevent the emission of smoke or secure complete combustion in the furnaces and combustion chambers. As the first method must result in a serious loss in the vessels' speed, the second method, in his opinion, gives the only rational solution of the trouble.

Mechanical Stoking

As an illustration Mr. Cary referred to an equipment for stationary boilers in which eighteen stokers had been operating 500 horsepower boilers 24 hours per day continuously for two years at 50 percent above their rating with average grades of eastern bituminous coal of no better quality than is used on transatlantic ships. They had been continuously burning from 42 to 45 pounds of coal per square foot of grate per hour with a clean smokeless chimney and have shown an easy forcing capacity when burning over 60 pounds of this coal per square foot of grate per hour.

The coal is fed by a mechanical stoker from a hopper to the fuel bed in a steady flow in such a manner as to avoid the trouble usually following its coke formation and the troublesome caking, and then it is moved along the grate automatically so as to constantly drop its ash directly down to the grate surface, where the cool entering air keeps the temperature of the ash below its fusing point, thereby avoiding the formation of obstructing clinker. The ash is dumped into an ash-sealed pit, where it is water-cooled and then carried forward into the front ash pit by an automatic device without disturbing the draft conditions of the furnace.

Only a light air blast pressure, seldom exceeding 1-inch water pressure, is necessary and this is supplied by an individual disk fan for each stoker requiring but little power to operate.

This method of mechanical stoking is suggested by Mr. Cary as a feasible means of reducing the smoke on vessets, although this equipment can be applied only to new vessels, as it is unsuitable for the average types of marine boilers with their present form of attached furnaces.

Osborn Monett, of the American Radiator Company, Chicago, declared that burning soft coal without smoke in marine boilers as a purely engineering problem is entirely feasible. Of the methods tried for this work the underfeed stoker probably has been best adapted and Mr. Monnett cited the following marine installations of the Jones underfeed stokers which are operating successfully to-day: The steamer *Sprague,* 6 Scotch boilers, 12 stokers; tug *Perfection,* 1 firebox boiler, 1 stoker; tug *Mollie Spencer,* 1 firebox boiler, 1 stoker; dredge *William O'Connell,* 2 double-end Scotch boilers, 8 stokers; steamer *Gamma,* 6 tubular boilers, 6 stokers; dredge *Hecla,* 2 Scotch boilers, 2 stokers; Ward Engineering Company steamers, 2 Ward watertube boilers, 4 stokers; Scandinavian steamer *Frederick VIII,* 8 Yarrow boilers 16 stokers.

As far as hand firing with Scotch boilers is concerned, experience, according to Mr. Monnett, has been discouraging, although he once succeeded in operating smokelessly a steamer so equipped, without any apparatus, simply by changing alternate fires. It happened that the boilers, two in number, were equipped each with three corrugated furnaces, all discharging into a common combustion chamber. The volatile matter from the fresh fire was consumed by the hot gases from the other two fires. With two furnaces the results would have been less satisfactory, and with separate combustion chambers (a common construction) impossible.

The idea in hand-fired furnaces has been to mix the gases, after they pass the bridge wall and while they are at a high temperature, with an auxiliary supply of air, and so accomplish complete combustion. Experiments have been made in Chicago harbor with brick arches, baffles and other constructions calculated to do this, but the small space available in the Scotch boiler has prevented satisfactory results. In fact, Mr. Monnett's experience with forced draft, induced draft, special air admission, preheated air, panel doors, steam jets, induction tubes, stack blowers, hollow bridge walls, etc., etc., has led to the conclusion, more strongly than ever, that some type of underfeed stoker is the logical answer to the Scotch boiler problem.

In watertube boiler construction, such as has been adopted by the Emergency Fleet Corporation, there is more opportunity to do things and it is not unreasonable to hope that a satisfactory hand-fired furnace for these units will be developed.

Lieutenant H. B. Oatley, U. S. N. R., chief engineer, Locomotive Superheater Company, New York, emphasized the difficulties of burning soft coal at or above the normal rate of operation with complete elimination of smoke. On new vessels the boilers, furnaces and uptakes can be so designed as to secure proper combustion, but on existing vessels unfavorable conditions may exist with respect to the proportions of air openings through the grates, volume of furnace and combustion chambers, area for gases through fire tubes and around watertubes and finally areas of uptake, breeching and stacks. The means for heating the air supplied in forced draft installations may also have been inadequately proportioned. While it is probable that to correct these conditions so far as the boiler itself is oncerned would be prohibitive on ac-

count of delay and expense in installing new boilers, nevertheless grates, uptakes and air admission generation may be corrected in a short time and at reasonable cost.

Above all, the personnel in the fireroom is a prime factor in dealing with this problem and great effort and expense are justified in giving all possible training to the fireroom crews.

Steam Economy a Big Factor

Lieutenant Oatley pointed out that steam economy is a big factor in the elimination of smoke because it results in reduction in the amount of fuel used and reduction in the rate of combustion. In the use of superheated steam, which offers an opportunity for reducing the fuel used by upward of 12 percent, and naturally a greater percentage reduction in the smoke produced, the marine boiler plants in this country are considerably behind the merchant marines in other leading countries. Superheated steam is particularly applicable to existing ships, as the necessary installation may be made at moderate cost during an overhauling. A reduction in the fuel used would make suitable many plants that have restricted areas through which the gases pass and permit of greatly improved combustion.

For existing ships Lieutenant Oatley believed there is a greater reduction in smoke to be expected by the more economical use of steam utilized under present conditions than by any other means.

Pulverized Coal

M. C. H. Hatch, of the Locomotive Pulverized Fuel Company, New York, stated that soft coal can be burned without smoke in marine boilers up to the point at which the furnace volume becomes too small to allow for proper air mixing and combustion space for the volatile hydrocarbons contained in the coal. Coal in pulverized form induces the desirable intimate mixing of gases and air very early in the process of combustion and less total air is needed per unit weight of fuel than with hand-firing. Basing his conclusion on locomotive and stationary practice, Mr. Hatch was positive that soft coal in pulverized form can be burned in marine boiler furnaces at much higher rates than can possibly be attained with hand-firing and that smoke will be eliminated or very materially reduced.

Henry Kreisinger also expressed the opinion that the best way of burning soft coal in marine boilers without smoke is to do away with hand-fired furnaces and use mechanical stokers or pulverized coal. For smokeless combustion, two requirements are essential: First, the volatile matter must be distilled at a uniform rate. Second, the distillation must take place in the presence of large amounts of free oxygen so that the volatile matter can be burned before the smoke is formed. These requirements are not satisfied in the hand-fired furnace. On the other hand, most of the mechanical stokers, as well as the powdered coal furnace, furnish means of satisfying these two requirements.

Most mechanical stokers feed the coal into the furnace at a uniform rate, so that the volatile matter is distilled also at a uniform rate. It is, therefore, comparatively easy to adjust a uniform supply of air to the volatile matter to insure its complete combustion without a too high excess of air.

Furthermore, with most of the mechanical stokers the air and the coal are fed into the furnace in the same direction, so that at the point where distillation takes place the air contains nearly 20 percent oxygen. On account of this large percentage of free oxygen the combustion of the volatile matter proceeds to completion without deposition of soot.

What has been said about the mechanical stoker is true of the pulverized-coal burner. The coal and air are fed into the furnace together at a uniform rate, so that the two can be easily adjusted to the proper proportion. The volatile matter is distilled from the small particles of coal, while the latter are surrounded with an atmosphere containing nearly 20 percent of oxygen.

With the pulverized coal a large part of the mixing of the combustible with the air can be done outside of the furnace. Thus the combustion space of the furnace needs to do only the burning and little mixing. Carrying on the mixing outside of the furnace deserves full consideration in the case of marine boilers, because the restriction of space on board ship makes large combustion chambers prohibitive.

Haylett O'Neill, who for the past two months has been running tests of marine boilers using pulverized coal at New Haven, Conn., stated that they had been able to burn this fuel without smoke and had obtained just as much speed and power as with the regular oil-burning equipment aboard the ship. The boilers were of the Normand express type with a very small furnace particularly unsuited to such fuel as powdered coal. Mr. O'Neill believed that the future will see much work done in marine practice in the way of substituting coal for oil inasmuch as fuel in the form of coal will cost about one-half or even one-third of what the oil will cost.

Plan for Simplifying and Standardizing Template Construction Suggested by Practical Shipbuilder*

BY FRED N. NELSON†

IN this national crisis, when ships are the Nation's first need, anyone who can save time in their construction and utilize the necessarily diluted labor to best advantage is performing a real service to his country. For that reason the following suggestion is offered in the hope that it may be found useful in simplifying and standardizing ship construction methods. No delays or radical changes are involved in the plan. It is simply an evolutionary improvement over old ways of doing things, a result of practical experience, and a proved success in saving time, money, tools, and material.

Outline of Plans

The improvement begins in the laying-out department, where the greatest saving is accomplished, reaching thence into the tool room and machine shop in connection with the manufacture of duplicating punches, many of which would no longer be needed by adoption of this plan. A very brief description of methods generally employed at present will help to a better understanding.

The evolution of shipbuilding has led to an ever-increasing proportion of the hull of the ship being developed in the mold loft and laid off from templates, showing all the details required. Practical shipfitters have followed their work into the mold loft and now make their templates there instead of "lifting" them from the ship as they used to do.

Care is Vital

It pays to do this work carefully, as every part developed must fit every other part, and mistakes mean

* From U. S. Employment Service Bulletin.
† Vice-president Seattle Metal Trades Council and now employed in the yard of Skinner & Eddy, Seattle, Wash.

wasted precious time and material. In these days of duplication of any number of hulls off the same molds, mistakes are multiplied in proportion; also, the same duplication makes it desirable and economical that the templates be as light and strong, simple and yet complete as possible for handling in laying off the work.

If the developing, making, marking, and checking of templates is done by ship-fitter loftsmen who know their business, who know how to make their templates "foolproof," a less skillful class of workmen can lay off the required number of plates, shapes, etc., without a reasonable excuse for making mistakes, one template perhaps, doing duty for various parts of the same hull and any number of hulls, all the details given on the template "foolproof."

This means a great deal in these days of abnormal demand for ships, and consequently for skilled men to build them. It saves mistakes and helps to solve the problem of making the really skilled men go as far as possible.

Wide Variation

The principal reason for this article is the fact that there is such a wide variation in the methods of various yards and sections in the construction and use of templates, which can be improved upon and save time in the construction of ships, and therefore have an important effect in winning the war.

The writer learned his trade at Bath, Me., when steel shipbuilding was in its infancy. Methods were crude, and nearly everything was "lifted." The custom there at that time was to mark location of holes with pieces of brass tubes dipped in whiting, which often gets rubbed off or misplaced, which causes omission of holes or holes punched in wrong places. Loft work was limited to fairing lines and making "scrieve board," besides templates for stem and sternpost, and later frames, though not on the universal system. The standard template wood used was three-sixteenths inch to one-fourth inch thick, of suitable width, mostly local pipe.

Best Kinds of Wood

Experience has taught us that templates made of Douglas fir or sugar pine are best, because these woods do not shrink or swell lengthwise, and therefore are not affected by moisture, like paper and other material experimented with. Also, work can be laid off more quickly and safely from wooden templates, and they can be stored away for years without changing.

Properly constructed they also stand rough handling, such as they are bound to get, especially where outside men work piecework.

At San Francisco the template wood used is similar, and the system there is to bore five-thirty-seconds inch holes for centers of holes, and the loft work is developed so that nearly all the hull is laid off from template furnished from the loft. The system is quite satisfactory, except that five-thirty-seconds inch holes make it necessary to "ring" the location and to first prick punch holes, then take the template off and center punch them, making two operations; also, the prick-punch marks being very light, holes are often missed, causing extra drilling and countersinking when work is assembled. The five-thirty-seconds inch holes were bored through templates in place on the floor with hand drills.

Seattle System

At Seattle the system in vogue was to bore templates the full size of the hole to be punched in the plates or shapes, which they thought made it necessary to make the templates of heavier wood, from three-eighths inch to one-half inch thickness, which made them very clumsy and hard to handle, and because of the big holes and the cut-outs leaving cross-grained pieces unsupported they were actually weaker than the templates made of lighter wood, which need not be cut-out except to working edges, and also can be more easily braced diagonally.

The chief objection, however, is the fact that this system required the use of duplicating punches of all the various sizes used, one type for wood for use in the mold loft, and other type for steel for use in the yard, of which each workman should have a full set, so that his time would not be wasted to borrow or steal the particular sizes needed.

The punches were too heavy to carry even one of them conveniently in the pocket. They are also quite expensive to make and easily spoiled; also the shoulder of the punch often catches on the side of the hole and tears the template when inexperienced workmen try to work fast. The output of the mold loft was often limited to the capacity of the boring machine, and at times templates otherwise ready to go out and needed were piled up for days waiting to be bored.

Improved Frisco System

Now the writer, on going to work in a new shipyard in Seattle, discovered an opportunity to improve on the San Francisco system without losing any of its advantages. He saw that the center punching could be done with one operation by simply boring the holes 3/8 inch and touching up the center punch to fit that size hole. This simple act also disposed of the many sizes of duplicating punches and made the center punch, which a ship fitter always carries in his pocket, his duplicating punch for all sizes, for no matter how large or small the hole it is always punched from the center and the size is marked by the ship fitter. It also permits the construction of templates both lighter and stronger than the Seattle system previously used and saves lumber and tools; 1/4-inch template wood is preferable, using 3/4-inch tacks for nailing.

The holes can be spotted on the top template and bored through all adjoining laps, butt laps or butt straps, stiffeners, bounding angles, etc., in place on the floor most conveniently by using a small drilling machine, either air or electric, which all shipyards have nowadays. There are other minor advantages which for brevity's sake we will not mention, but which in the total count up.

How to Prevent Boring Floor

The 3/8-inch bitts are not as easily broken as the 5/32-inch and can be prevented from boring into the floor by slipping a piece of waste wood under template while boring and also by filing threads off, leaving the point. Boys quickly get to be experts at boring holes fair through several thicknesses at a time.

The plan is absolutely practical and will help solve the problem of utilizing the less skilled ship fitters to best advantage; it will save hundreds of thousands in money, tools, and materials, and save time, which cannot even be calculated in terms of money at this time.

The careful study of the walking beam of a beam engine shows most clearly the relation of strains to movements. The slower the movement the greater the strain on any part.

Why are the steep threaded bolts so much used in a shipyard for erecting not more frequently used in boiler work? They save time.

End-Launching of Vessel in Narrow Stream

Vessel Starting Down the Ways at High Velocity Brought to a Standstill at End of Ways by Unusual Means of Control

BY MAX HAUSEN*

THE launching of the S. S. *Beaumont,* the first Ferris type wooden steamship, built at the McBride & Law shipyard, Beaumont, Texas, which took place at 4 P. M., on Friday, June 28, was of special interest because of the difficulties that were encountered, due to the nearness of the opposite shore.

Because of the fact that the yard was located in the heart of the town, which afforded considerable advantage in the facility of the handling of materials, securing labor and affording protection, there were serious limitations as to the location of an advantageous position for launching on account of railroad tracks and town sewerage lines which could not be removed.

S. S. *Beaumont* Immediately After Launching

The launching ways were laid at the greatest possible angle to the shore line which the above condition would permit, resulting in about 450 feet of water in line with the vessel, but, after deducting the length of the submerged ways, which was 130 feet, and that of the vessel, which was 270 feet, the remaining possible travel of the vessel after leaving the ways was only 30 feet, taking into account 20 feet of shallow water. These conditions made it apparent to the writer that the vessel would have to be stopped immediately after she left the ways. This result was successfully accomplished by utilizing several unusual methods as described below.

The keel was laid with a ⅝-inch grade. Due to the limited launching space the keel at the stern was laid as low as possible, about 3 feet above mean water level. Because of this, the ways were built with a slight crown, of about 12 inches, the highest point of which was drawn tangent to a ¾-inch grade line at the rudder post, thus creating a declivity ranging from .642 inch to .804 inch, with a corresponding estimated free speed of from 4 feet to 22 feet per second. The momentum developed by the vessel going down the ways under these conditions would have been from 1,560 to 13,200 foot tons.

The above figures made it very apparent that it was hardly probable for the vessel to be successfully launched without retarding her speed. It was, therefore, decided to maintain a speed of from 7 feet to 10 feet per second, with a momentum of about 1,800 foot tons for three-quarters of the length of the ways and a gradual reduction of speed to a standstill at the end for the balance of the travel.

Braking Devices

This was achieved by means of a massive friction brake of live oak, with two 6-foot diameter wheels controlled by heavy steel brake bands. The brake was connected to the vessel with a 2-inch diameter steel wire cable. A bulkhead was also built at the stern below the arch, and this proved to be of considerable help in retarding the vessel.

As a further precaution two 2-ton anchors were buried about 8 feet in the ground and connected to the vessel by the anchor chain. They were controlled by the windlass on board the ship. Two 3-inch manila hawsers, fastened to the shore for holding the vessel, did not go into action.

Two extra anchors were dropped as soon as the vessel hit the water. Under pressure from the Government, the opposite shore was dredged out for 120 feet in line with the vessel. This, however, as the launching proved, was entirely unnecessary.

The actual launching proceeded in a manner slightly different from that originally contemplated, due to changes made in the control of the brake, which was changed from a one-man balanced level control to a triple block handled by ten men. The moment the dock shores were removed the vessel started, breaking the rope lashings around the ways. The unusually rapid start of the vessel was doubtless due to the perfect working of the launching grease.

Speed of Vessel Down the Ways

She gained a speed of about 11 to 12 feet per second in the first 120 feet of travel down the ways, when the order was given to the brakeman to check her. The instantaneous full application of the brake caused the 2-inch diameter steel wire cable to snap because of the lack of a sensitiveness in the sheave block control. The tearing of the cable, however, retarded her speed considerably. At this time the stern bulkhead met the resistance of the water, which slowed the vessel down still more, reducing her speed to about 4 to 5 feet per second in the next 100 feet of travel. At this point the anchor chains became taut, and, being intelligently controlled by the men handling the windlass, the paying out of the cable was gradually lessened until the vessel was stopped exactly as desired.

* Naval architect in charge of construction, McBride & Law Shipyard, Beaumont, Texas.

Taken altogether this was a most extraordinary launching, as the vessel, starting with a high velocity, was gradually slowed down until she passed over the end of the ways, when she was brought to a standstill. If the brake cable had remained intact a more perfect control would doubtlessly have been maintained over the vessel.

The *Beaumont* was built along the lines of the original Ferris type of construction; but reinforcements were built into the hull, as recommended by the American Bureau of Shipping, which make her one of the strongest of the vessels of this type that are being built. According to the chief surveyor of the American Bureau of Shipping, the *Beaumont* will receive the highest classification that can possibly be given to a vessel of this character.

Oregon Contributes First Wooden Steamship to Emergency Fleet

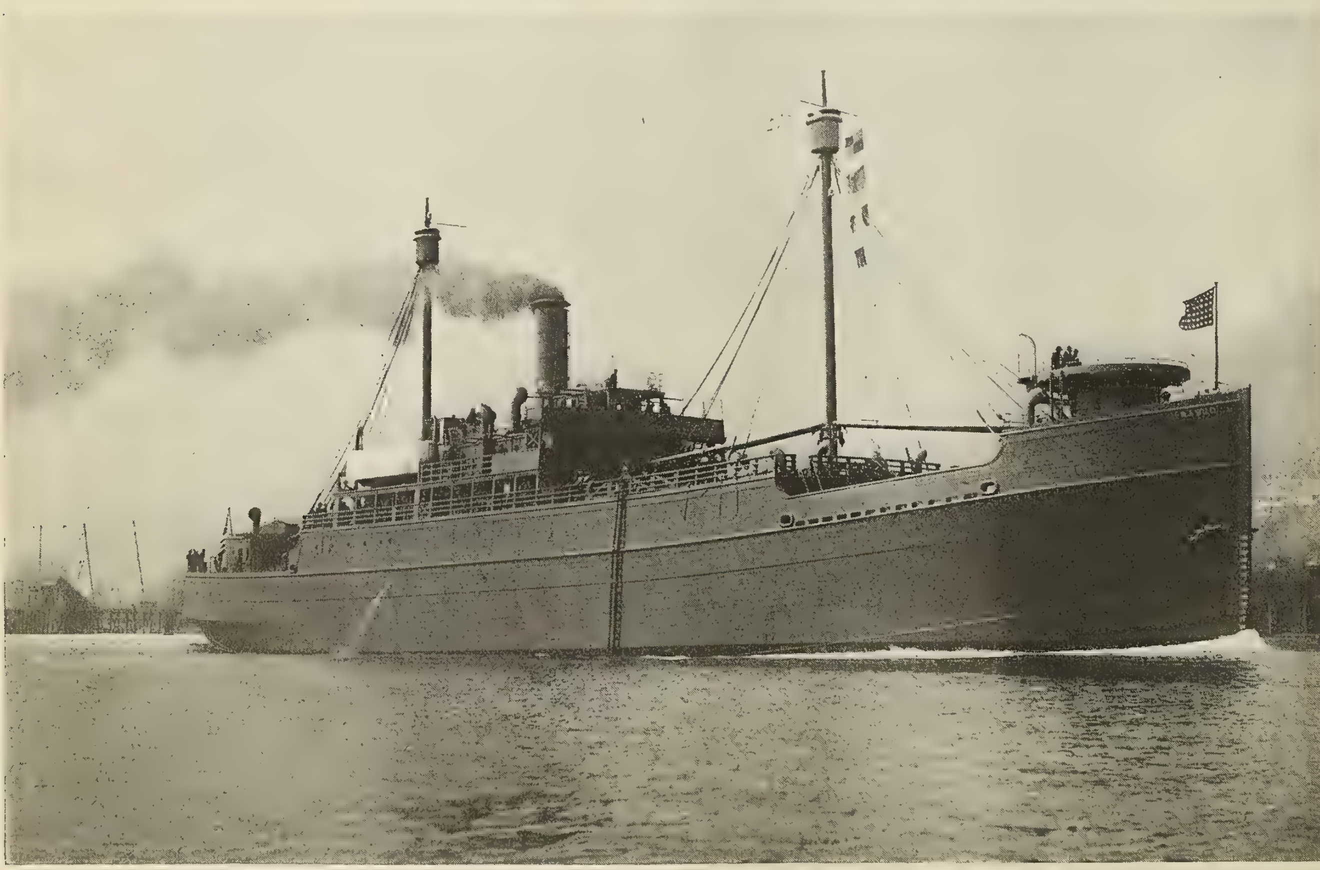
OREGON has gathered in the honor of delivering to the Emergency Fleet Corporation and sending to sea the first completed wooden ship of the mighty flotilla that will compose the merchant marine of the United States, and which is intended to aid in winning the war. The vessel was the *Wasco,* 286 feet in length, 46 feet beam, and capable of carrying 3,600 tons of freight under her hatches at a speed of 12 knots.

The big wooden freighter was registered under Government ownership at Portland, Ore., June 9, and left down the Columbia River for the open sea at 10:15 A. M., on Wednesday, June 10. Every item of equipment was in place and ready for use. The dates are particularly set down because it is an historic event. It was the first response to the undersea murder campaign of the Hun. It was the answer to President Wilson's call to labor. It was the contribution of a man who is building ships without retaining a nickel of the profits for himself, but who is putting portions of his private resources into Red Cross work and giving other sums for the relief of suffering among the allied nations and to the support of government activities.

Doubtless there are other American citizens who are backing the boys in the trenches as is Eric V. Hauser, hotel man and contractor, and their stories ought to be told for the encouragement of American spirit. The stories of such work are worth telling. Portland and Oregon were first over the top in the Third Liberty Loan drive because of having organized a working machine in advance of the date for securing the money. Mr. Hauser gave Portland the honor of furnishing the first wooden ship to the government because of having organized his shipyard into a machine for whipping the everlasting tar out of Germany.

So earnest are the men that they delivered four more wooden ships to the Emergency Fleet Corporation before July 10. They are the *Biloxi, Kasota, Blandon,* and *Boilston.* The *Biloxi* was delivered to the Government under full steam and in complete operating condition on June 18, nine days after the *Wasco* was delivered. These vessels are sisters to the *Wasco* and of the same type and size. Seven others are in the water and men are swarming over them in the work of fitting their equipment.

Enthusiasm is the keynote of operations at the shipyards where those boats were constructed. Heavy timbers swing into place to the music of popular war songs as whistled by the men. Mechanics are on edge to get their particular job completed because they realize that the boat on which they work is needed to carry forward the supplies the army wants, and because the people of Portland honor the men in the shipyards as they do the



S. S. *Wasco,* First Wooden Ship to be Fully Equipped and Turned Over to Emergency Fleet Corporation, Built at Portland, Ore., by Grant Smith-Porter Company

men in the trenches. That combination of workers and sentiment is what is going to give the Emergency Fleet Corporation a fleet within the next six months.

So strong is their belief in themselves that the men of the Hauser shipyard have placed a certified check for $10,000 (£2,050) in the hands of Meyer Bloomfield, of the Fleet Corporation, to back up their claim that they can build more ships and build them faster than any other wooden shipyard in America. These men are the sort of fellows who "eat this war stuff."

When a Red Cross subscription is announced, or a liberty loan, the shipyard workers say "How much from us?" Then they set aside so many days' pay for each man. And just inside the front gate of the big yard is a liberty rail, painted red, white and blue. On it any slacker is ridden from the enclosure.

It was not always thus. In the summer of 1917 Eric V. Hauser happened to be living in the big fir district of America when the necessity for wooden ships was announced from Washington. He had retired after years of railroad building as a member of Grant Smith & Company, of St. Paul. Mr. Hauser had no shipbuilders at hand, but he knew the men of the old Grant Smith crew.

Starting the Shipyard

Messages over the wires brought them together at Portland. They looked at the plans for a wooden ship of the Hough type, and said they could build it. Mr. Hauser took their word for it, and accepted contracts from the government for about thirty ships. In September the keels were ready to be laid down; but workmen who had been assembled got some kind of a grievance in their minds and went on strike with shipyard workers at other plants.

After the men went back to work in November, 1917, Mr. Hauser devised a plan to put them on edge, give them "pep" and make them see the importance of their labor in the great scheme to win the war. He arranged for the foremen of each shift to meet him at luncheons and dinners. At those dinners he convinced the men of his friendship and interest in their prosperity; he had Dr. William T. Foster, among others, tell them of the horror he had seen along the German trail in Belgium and in France; soldiers from the front told the shipbuilders their stories, and every speaker asked for ships, and quick delivery.

Out at the yards a band was organized to entertain the men during luncheon hours, several times each week patriotic speakers addressed the men; baseball teams were organized; a newspaper was printed carrying only shipyard news; bonuses were furnished workmen who were drawing a minimum of $3.25 (13/6½) and a maximum of $6.00 (1/5/0) each day; a community house was constructed where the men are given shower baths, amusements, and lockers for their clothing.

The *Wasco*, the first ship delivered to the Emergency Fleet Corporation, and her sister ships are the first syllable of the answer the men made. When the representatives of the Emergency Fleet Corporation, Lloyd J. Wentworth and J. W. Hall, cast loose the hawser and seized the halyards to raise the pennant of the corporation over the first wooden ship to be delivered to the Government, 3,000 workmen stood on the wharf and clung to the frames of embryo ships on the ways to cheer the departure of their first gift to Uncle Sam. They were proud of it.

Round corners on the top and bottom of a tap require a specially formed tool. Such a tool is expensive and not easily produced by the ordinary tool maker.

Shipbuilding in Japan*

JAPAN'S mercantile marine now well exceeds 2,000,000 tons. The official figures for the end of 1916 gave 2,170 steam vessels, aggregating 1,704,785 tons, and 9,187 sailing ships of 572,403 tons. In 1916 the Japanese yards completed 250 merchant vessels of 246,000 tons—more than twice the tonnage attained in any previous year—and when the figures for 1917 are available it will be found that the 1916 output has been much exceeded, in spite of the great difficulties in the way of importing materials.

Japanese shipbuilding owes much to State assistance. As recently as 1894, only 84 steamers of 1,000 tons or more were owned in Japan, and of these only one had been built in that country. But in 1896 the twin trades of shipping and shipbuilding received a great stimulus by the enactment of the now famous Shipping and Shipbuilding Subvention Law, which became operative in 1897. In the last year preceding the payment of subsidies the total output of Japanese yards was only 5,860 tons of steam and 1,061 tons of sailing (ocean-going) vessels. By 1900 the tonnage launched had increased to 15,380 steam and 17,873 sailing. For 1913, the last year before the war, the total output was 63,664 tons, nearly all steam. In 1914 the tonnage was 85,861; in 1915, 106,388; in 1916, 246,000; and last year something considerably over that tonnage. For 1917 the vessels completed under the terms of the Subsidy Law—that is, ships of not less than 1,000 tons—numbered 69, with an aggregate tonnage of 299,684 tons. It is estimated that with small craft, together with wooden ships of 1,000 tons or more not entitled to subsidies, the total output for the past year will have been at least 400,000 tons. On January 1, 1918, there was under construction in Japanese yards not less than 1,330,000 tons, though building was being delayed through shortage of materials, and many berths were empty. Japan now ranks third in tonnage built, and fifth in tonnage owned, amongst the world's nations.

New Subsidies Act

Under the Subsidies Law the output of the yards increased from 13,000 tons in 1897 to 78,000 tons in 1908, the subsidies in respect of both shipping and shipbuilding having increased in that period from 1,944,000 yen to 13,166,000 yen. In the next year, 1909, the output declined to 55,000 tons—a decrease of 23,000 tons on 1908. That was considered unsatisfactory, and a new Subsidies Act was carried. This came into force at the beginning of 1910, and the twin trades received a fresh impetus. The new law was framed to give smaller subsidies in respect of navigation, or shipowning, but more liberal terms in respect of the building of large vessels. Bounties of from 11 yen to 22 yen per ton of gross measurement were paid in respect of steel ships of not less than 1,000 tons, according to type, with an additional bounty upon the engines of 5 yen per indicated horsepower. Under the old law the bounty was a round 20 yen per ton for vessels of not less than 700 tons gross.

The new law aimed at the maintenance, or development, of certain specified trade routes, and the encouragement of larger and faster ships. It left the Minister of Communications discretion to refuse bounties to vessels of less than 3,000 tons if they were of less than 12 knots speed, or were employed upon undesirable routes. He was also empowered to grant increased rates of bounty up to 25 percent on the base in respect of vessels run on

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* From *Engineering*.

trades which might not be profitable, but which it might be specially desirable to maintain for Imperial reasons. An age limit was also imposed; and speed was considered. Ships built of steel in Japan, and owned in Japan, of not less than 3,000 tons gross, of not less than 12 knots, and not more than five years old, were subsidized at a rate of 50 sen—that is, half a yen, or about 1*s.*—per ton per 1,000 nautical miles' run. For every knot of speed beyond 12 per hour there was a bonus of 10 percent on the base bounty. On the other hand, when a ship exceeded five years of age there was a 5 percent reduction for every year until fifteen years were reached, when the subsidies might be withdrawn by the Minister of Communications. The Ministry was also authorized to grant subsidies at half the ordinary rates to foreign-built vessels if he thought fit. In the twenty-one years in which the Subsidies Act was in force the amounts paid totaled 160,000,000 yen—say, 16,000,000*l.* Recently—with the shipowners enjoying abnormal profits on account of the war, and in view of the high prices they are prepared to offer for new vessels—a new law has been carried suspending the payment of the subsidies in respect of the building of ships. The Osaka Shosen Kaisha, owning 378,000 tons of shipping, and with a paid-up capital of 3,106,250*l.*, had a profit of 1,834,724*l.* for last year, after allocating 121,-500*l.* to the insurance fund, 162,000*l.* to the repair fund, and 101,000*l.* for depreciation of the fleet. Generally the profits of Japanese shipping have been, to quote *The Financial Review of Reviews,* "immense."

Japan's Shipbuilding Resources

Regarding the rapidly increasing shipbuilding resources of the "Britain of the East" it may be mentioned that the country has about 120 berths capable of taking vessels of 1,000 tons or more. The capacity has been increased threefold since the war started. Perhaps the most notable of the Japanese shipyards is the one on Nagasaki Harbor, founded by the Government in 1857, but sold to a private capitalist in 1884. Shortly after the establishment of this State enterprise two or three yards and engine works were started by private people, but little or no financial success was met with. In 1868 the Imperial yard was placed under the management of an Industrial Department specially formed for the purpose. This body went in for merchant as well as naval building. Then a second Imperial yard was started at Kobe, and the best of the private plants were nationalized. The builders of fishing and other small craft tried to approach the Western style of construction, but the financial results were mostly disappointing. As mentioned above, in 1894, out of 84 Japanese steamships of 1,000 tons or more, only one had been built in Japan. But the Subsidies Law changed the situation. However, in 1884 the Imperial yard at Nagasaki became the private property of Baron Iwasaki, and is now known as the Mitsu Bishi Works. When it was denationalized in 1884 it employed 800 men, after twenty-seven years of State control. When the present war broke out it employed about 10,000 men. Last year this company launched 10 steamers ranging from a tonnage of 3,163 to 7,317. At the beginning of this year the firm had 13 steamers of an aggregate tonnage of 63,000 on hand. Before the recent war-time extensions, the principal yard of this concern covered 115 acres, it had nearly 1½ miles of water frontage, three dry docks of 350 feet, 510 feet and 714 feet in length, a patent slip 750 feet long, and seven building berths ranging from 185 feet to 700 feet long. Ten years ago this firm built two of the finest turbine passenger vessels of the day. The company has another yard at Kobe.

The principal yard of the Kawasaki Dockyard Company, at Kobe, like that of the Mitsu Bishi, was originally founded by the Government, but sold into private hands in 1886, and subsequently passed to the present ownership in 1896. Until about ten years ago only torpedo craft and small gunboats were built here for the Japanese and Chinese Governments, but in 1908 two merchant vessels, each of 8,600 tons, were launched. On the eve of the war this yard had a frontage of nearly a mile, and four building berths of from 400 feet to 600 feet in length, besides several for smaller craft. The company built its own steel foundry about ten years ago. Last year this concern launched 21 steamers of from 1,570 tons to 9,400 tons. It has just lately built a new plate mill.

Perhaps third in rank of capacity is the shipyard known as the Osaka Ironworks. This was founded by an Englishman, Mr. T. H. Hunter, in 1880, and was still owned by him less than ten years ago, and for anything the writer knows to the contrary Mr. Hunter is still living and controlling the yard. The concern comprises, besides the principal yard at Sakurajima, covering 16 acres, with a water frontage of 1,000 feet, and three dry docks, engine shops at Ajikawa Guchi, and repairing works at Temposen. Last year this company built 19 ships of from 1,212 tons to 7,789 tons.

Altogether there are over 200 shipbuilding and repairing yards in Japan, though most of them are limited to the construction of fishing and other small craft. About a dozen can build modern ocean-going ships. Besides the three companies just named, mention may be made of the Uraga Dockyard Company, which launched eight vessels of about 8,000 tons each last year; the new Ansano Company, seven ships of about 900 tons; the Yokohama and Fuginagata Companies, which launched several vessels up to 3,000 tons.

Of the four Imperial yards, the Kure and Yokosuka establishments have each accommodation for the construction of the largest battleships and cruisers, while the Sasebo and Maizuru yards are specially adapted for the building of smaller types of war vessels. These four yards, needless to say, are furnished with every appliance necessary for the rapid handling of materials. At Kure is the Imperial Arsenal, with its armour plate and big-gun shops, as well as the shipbuilding yard. At Sasebo there are three huge dry docks.

Preparations for Securing Trade After the War

A notable development in the Japanese shipping and shipbuilding trades is a movement towards a community of interests for securing trade after the war as well as for obtaining supplies of material during the war. Several of the purely shipbuilding concerns are combining in order that the various yards can be put exclusively on the classes of work for which they are most economically adapted, and combines are being formed among colliery owners, iron mining concerns, steel works and shipbuilding firms, with a view to bringing all phases of production under single managements. The methods of the German cartels in the co-operative buying of raw materials and disposing of finished goods are also being carefully considered. But primarily the difficulty is that of securing supplies of shipbuilding materials, and for this purpose such leading firms as the Mitsu Bishi, the Kawasaki, the Asano, the Uraga and the Yokohama dockyard companies have formed an association called the Sempaku Kyokai.

The Secretary of the Swedish Legation at Tokio reports that with a view to the further encouragement of the shipbuilding industry it has been decided to establish

a loan bank in Japan for advancing money on the security of ships under construction, on lines similiar to the Ship Mortgage Bank of Hamburg. The nominal capital is to be slightly over 2,000,000*l.*, but the concern will be able to enter into engagements up to ten times this amount, and efforts are being made to obtain Government assistance, or a guarantee.

Regarding the possibilities of Japanese competition with ourselves generally, it may be observed, first that current extensions of manufacturing and shipbuilding capacity, and of additions to our Eastern ally's mercantile fleet, are being made under abnormal conditions, at enormous cost for materials, which means most extravagant capitalization, and that the enterprises involved will thus find themselves heavily burdened with capital charges when prices and freights become anything like normal again, whereas our capitalization will be little or no more per ton of either manufacturing or shipping capacity, than it was before the war; and, secondly, that through shortage of plant, machinery, and skilled labor, it will be many years, even under the most extraordinary circumstances, before Japan can offer us any really serious competition.

Model Experiments on Express Cruisers of Deadrise Type

For High Speed Length Ratio Deadrise Type Proves Superior to Round Bilge Model—Resistance of Appendages Investigated

BY T. A. GAMON

EARLY in 1917 the speed and power question came up with reference to 72-foot express cruisers. We were in the position of having to face a trial with a displacement length coefficient unusually high for the speed length required. To arrive at a solution of the resistance speed question, several models of the deadrise type were tested for us by Professors H. C. Sadler and E. M. Bragg, at the University of Michigan model tank. Through the courtesy of Captain A. P. Lundin, president of the Welin Marine Equipment Company, the following results of these tests are published.

As the time available did not permit an extended series of tests, five models were used, elemental in form, having certain charactertistics assumed as favorable for resistance at high speed length ratios, and other characteristics, the effects of which were uncertain. It was hoped that careful analysis of these results would form a basis for a final set of lines suitable for the conditions laid down.

The following table gives the various dimensions and characteristics for the models.

The lines for model No. 5, are lines of model No. 1, contracted 27 percent in draft and expanded 27 percent in beam.

Fig. 4 shows the curves of total resistance and estimated frictional resistance, for the five models, all at 4.29 pounds displacement fresh water at E. K. and bare hull condition. As regards the estimated frictional resistances, the following may be said: Estimating frictional resistances by the usual method with the formulæ $R_f = fAV^n$, f, A and ^{n} are assumed as constant for a particular model at all speeds. Within the usual speed length ratios this is practically true, and for models Nos. 1, 3, 5 and 6, where, within the speed runs, in no case did the fore foot come out in water, this method was used. The values of f^n, and A used, being .01123, 1.94, and the areas of wetted surface to normal L. W. L., respectively.

Referring to Fig. 3, in which the wave profiles for model No. 2 are given at various speed length ratios $\frac{V}{\sqrt{L}}$, it will be seen that at high speed length ratios the fore foot came out of water. The wetted surface and mean immersed length did materially reduce at high speeds. So in this case the values of f, A and ^{n} should vary with the speed V. The curve of estimated frictional resistance for model No. 5 was estimated by a suitable adjustment of f, A and ^{n} with speed.

TABLE I.—DIMENSIONS AND CHARACTERISTICS OF MODELS

Model No.	Length L. W. L. in Ft.	Beam L. W. L. in Ft.	Draft to L. W. L. in Ft.	Corresponding Disp. F. W. in Lbs.	Max. Sect. Area in Sq. Ft.	Location of Max. Area.	Wetted Surface to L. W. L. in Sq. Ft.	C of B Aft $\frac{L}{2}$ in Ft.	$\frac{B}{H}$	$\frac{L}{B}$
1	3	.4475	.1387	4.29	.0368	$\frac{L}{2}$	1.41	.0285	3.23	6.70
2	3	.4375	.1180	4.29	.0389	11% Aft $\frac{L}{2}$	1.365	.238	3.71	6.86
3	3	.4125	.1440	4.29	.0343	$\frac{L}{2}$	1.355	.054	2.86	7.27
5	3	.5680	.1092	4.29	.0368	$\frac{L}{2}$	1.575	.028	5.20	5.27
6	3	.4475	.1440	4.29	.0347	$\frac{L}{2}$	1.485	0	3.11	6.70

The transoms are all square and dead flat on the bottom.

The sections are all practically right line except for model No. 6, which are concave below the chine.

All chine lines in profile make about 3 degrees with the normal L. W. L. forward except for model No. 2, which makes an angle of about 5 degrees.

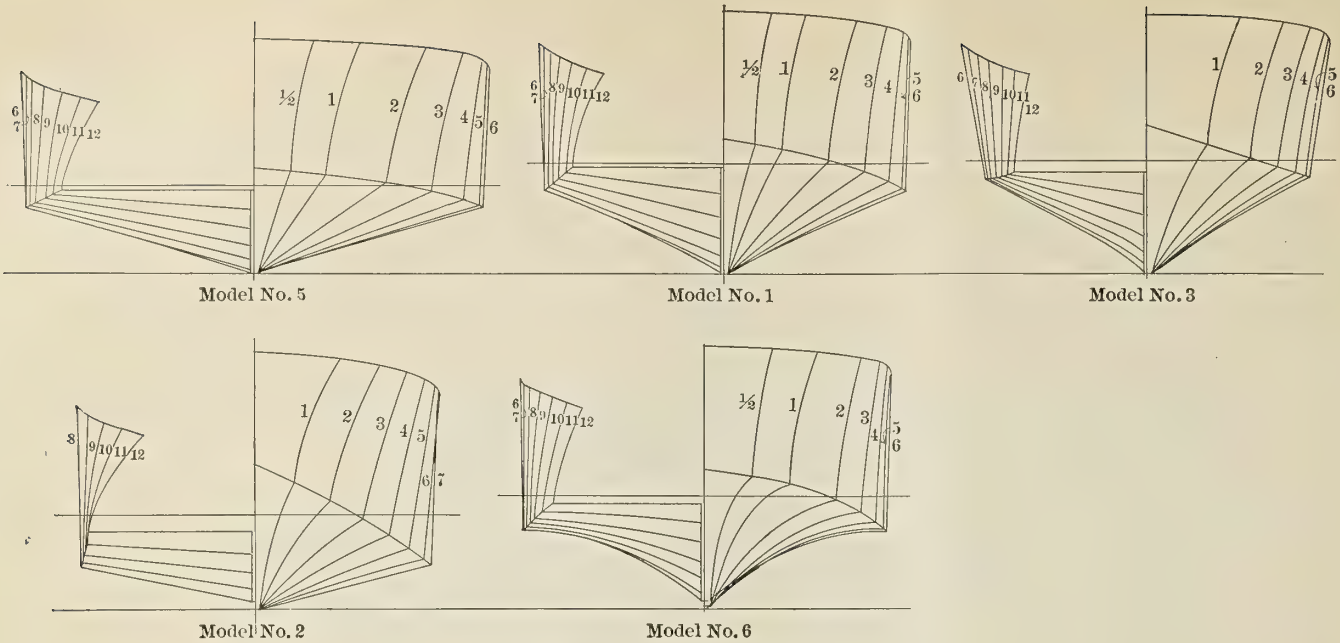
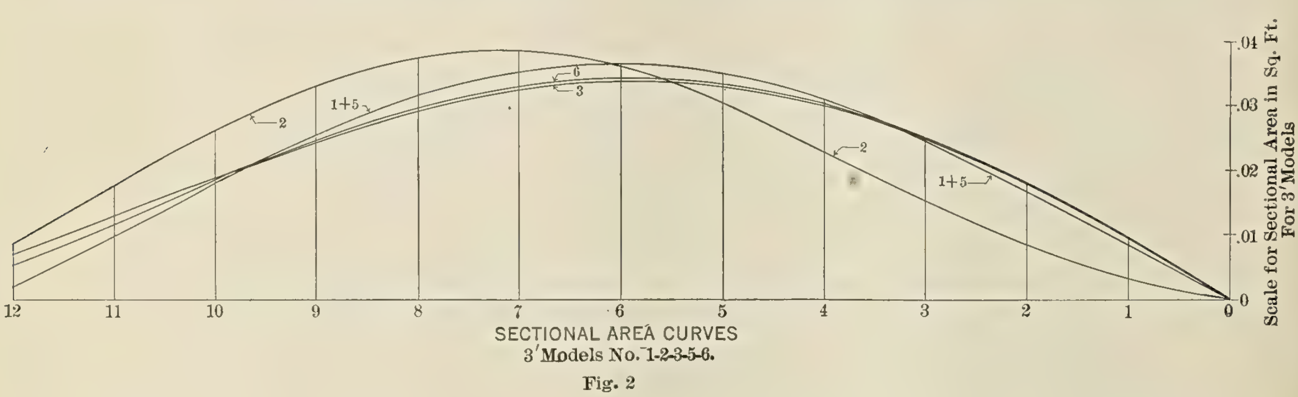


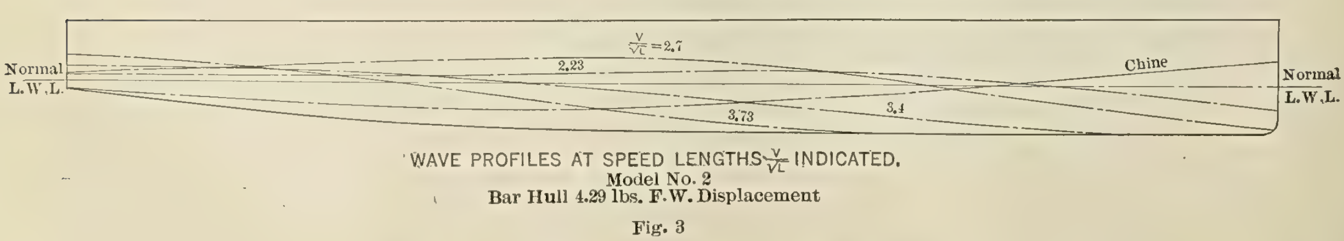
Fig. 1.—Body Plans

Resistance Curves in Fig. 4

Referring to the body plans on Fig. 1, the sectional area curves on Fig. 2, and the table of dimensions, it will be seen that models Nos. 1, 3 and 5 are practically the same except for values of $\frac{B}{H}$. The curves on Fig. 4 indicate that up to a speed length ratio of about 3.8, both frictional and residuary resistance increase with $\frac{B}{H}$. Above a speed length ratio 3.8 the indication is that the residuary resistance and total resistance does not increase but rather decreases with $\frac{B}{H}$. Below a speed length ratio of 3.4 at any particular speed, the ratio of frictional resistance to total resistance is practically constant for the three values of $\frac{B}{H}$, and increases from .45 at $\frac{V}{\sqrt{L}} = 1.6$ to .7 at $\frac{V}{\sqrt{L}} = 3.4$.

Model No. 6 is very similar to model No. 3 except that the $\frac{B}{H}$ for model No. 6 is slightly greater and has concave sections. Referring to the curves on Fig. 4, it is evident that allowing for the slightly greater $\frac{B}{H}$, model No. 6 is still inferior to model No. 3; and though one model hardly justifies a conclusion, it seems that concave





Figs. 2 and 3.—Sectional Area Curves and Wave Profiles

sections are not beneficial for reducing the resistance. The curves of total resistance (see Fig. 4) for models No. 2 and 5 agree quite closely in general character and greater angle of chine with L. W. L. are detrimental to speed. At extreme speeds with the wetted surface and mean immersed length decreasing, due to abnormal trim,

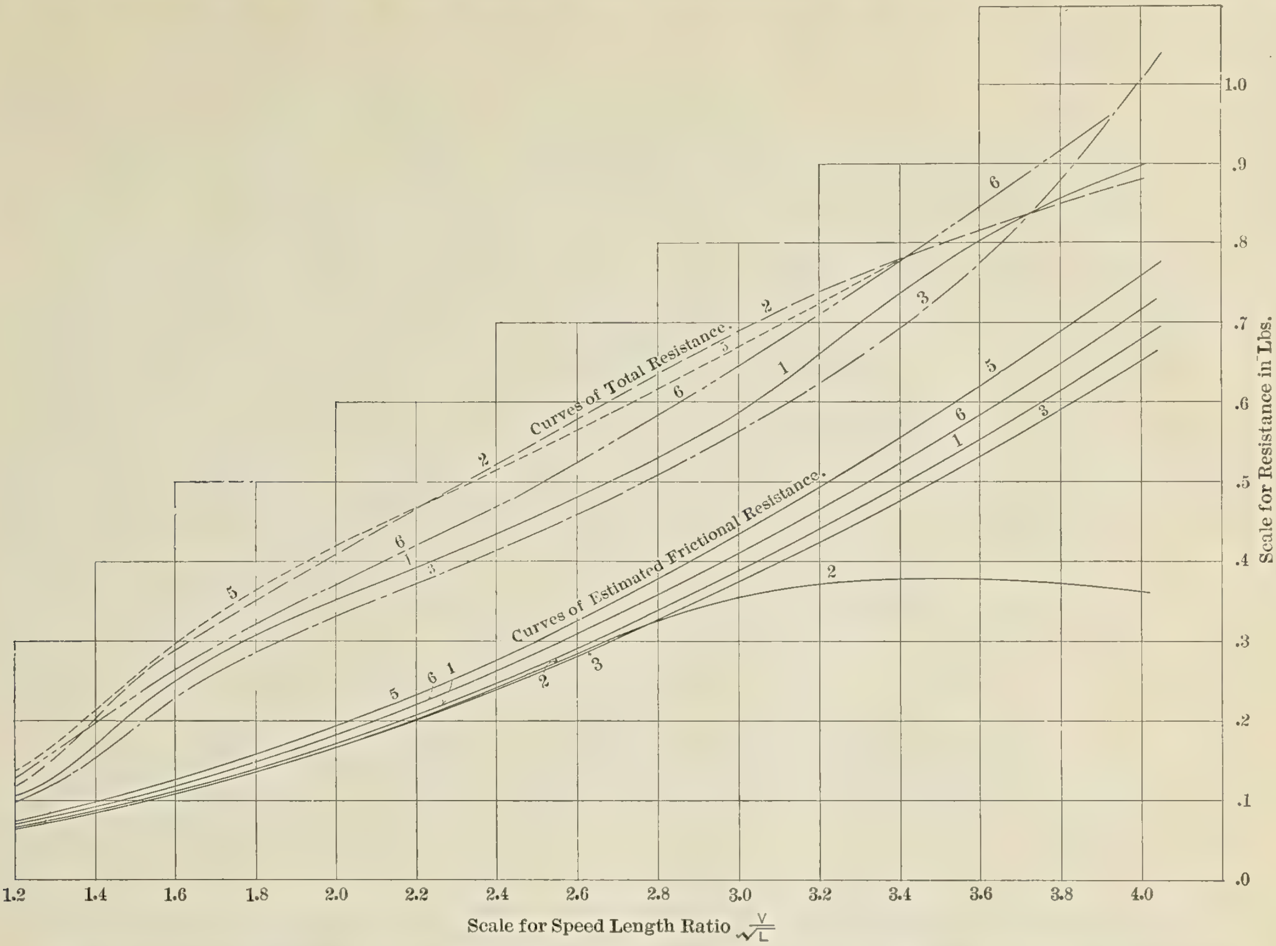


Fig. 4.—Curves of Resistance for 3-Foot Models Nos. 1-2-3-5-6, All Bare Hull at 4.29 Pounds Fresh Water Displacement

in value in spite of the fact that model No. 5 has greater $\frac{B}{H}$ and wetted surface than model No. 2. Apparently the very fine sectional area curves forward associated with the ratio of friction to total resistance is falling off so rapidly that when estimating the effective horsepower for full sized hull the inferior resistance qualities of model No. 2 are very apparent.

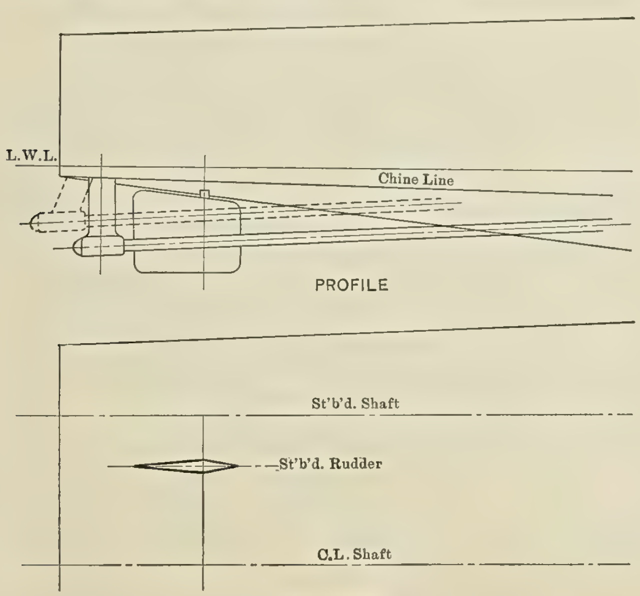


Fig. 5.—Appendages as Fitted to Model No. 1. Full Lines Indicate Arrangement No. 1; Dotted Lines, Arrangement No. 2. Rudders, in Size and Location, Same in Both Arrangements.

APPENDAGE RESISTANCE

Fig. 5 shows two arrangements of appendages as fitted to model No. 1, and Fig. 6 shows the curves of total resistance for the model run in all cases at 4.29 pounds displacement fresh water. Both arrangements are for three shafts and struts and two rudders. In both cases the rudders are the same in size and location, but arrangement No. 1 gives submerged propeller tips, whereas arrangement No. 2 gives the propeller tips emerged. The resistance curve for arrangement No. 1 shows a greater increase over arrangement No. 2 than was expected after allowing for increased length of struts and shafts, but it is reasonable to suppose that the decreased propeller efficiency for arrangement No. 2 would offset this increase in resistance. Arrangement No. 1 gives an increase in total resistance over that for bare hull condition of from 19 to 25 percent, and arrangement No. 2 from 6 to 12 percent. As is well known, model experiments exaggerate appendage resistance, and it is reasonable to assume that the appendage resistance would amount to from 15 to 17 percent of the total bare hull resistance.

Fig. 7 shows in full lines the resistance curves for model No. 5 run at bare hull condition and four displacements, as indicated, and in dashed lines estimated resistance curves for a round bilge type having the same length,

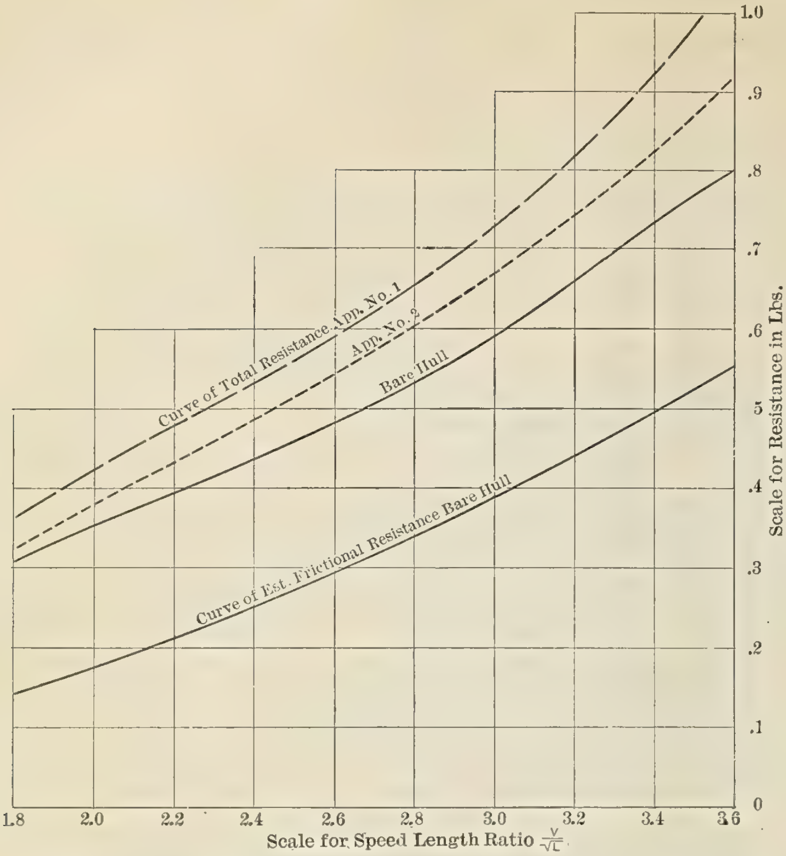


Fig. 6.—Curves of Resistance for 3-Foot Model No. 1, Bare Hull, with Appendages No. 1 and No. 2 as Shown in Fig. 5, All at 4.29 Pounds Fresh Water Displacement.

beam, draft and displacements as for model No. 5. The curves indicate that at any particular speed length ratio the resistance increases almost directly with the displacement, and the rate of increase is nearly the same for both types. The range of displacement length coefficient, $\frac{\Delta}{\left(\frac{L}{100}\right)^3}$, is only 69 to 87, and at lower values it may be found that in the deadrise type the resistance increases at a much greater rate with displacement. Of more importance, however, is the fact that there is a region in speed length ratio within which the deadrise type is superior from a resistance standpoint and a region within which the round bilge type is superior. The general speed service at which the hull is to be placed will determine the most advisable type tc use. In case the hull is to be generally run at relatively low speed length ratios, the round bilge type is undoubtedly superior. Where the service requires a continuous high speed length ratio the deadrise type is superior. The feasibility of powering the hull to land within the beneficial speed length ratios must be considered.

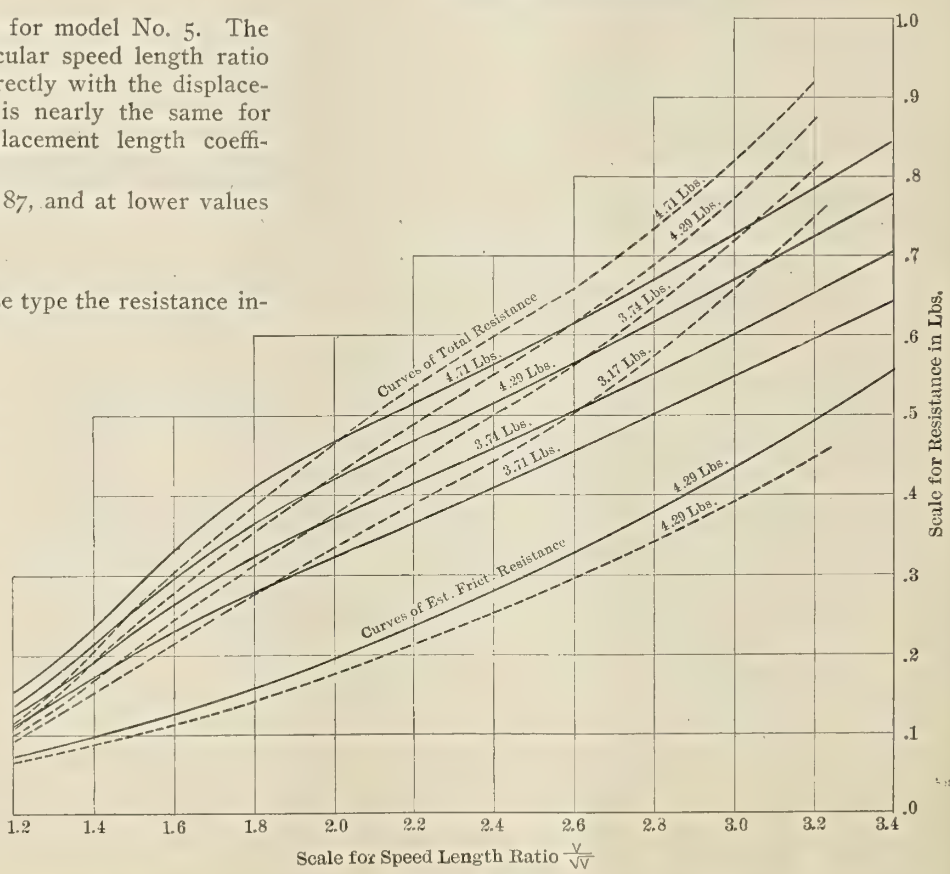


Fig. 7.—Curves of Resistance for 3-Foot Model No. 5 at Fresh Water Displacements Indicated for Bare Hull and Estimated Curves of Resistance for Round Bilge Type Having Same Length, Beam, Draft, Displacement and for Bare Hull. The Full Lines Are Curves for Model No. 5 and the Dash Lines the Estimated Curves of Resistance.

Engineering Section of Emergency Fleet Corporation

The Technical Department of the Emergency Fleet Corporation will be known hereafter as the Engineering Section of the Steel Ship Construction Division. H. C. Sadler, formerly professor of naval architecture at the University of Michigan, is naval architect and consulting engineer in charge of the Section.

Duties of New Section

The duties of the Engineering Section will be preparing designs, plans and specifications for ships, examining and commenting upon contractors' plans and specifications submitted for proposed contracts, examining and approving for delivery the final contract, plans and specifications, examining and approving contractors' plans submitted for approval of the Home Office, preparing specifications and plans for articles purchased direct by the Fleet Corporation, and examining and reporting on technical matters referred for such purposes by the manager of the Division.

Brill Heads Requirements Section

George M. Brill has been appointed head of the Requirements Section of the corporation, and J. H. Kirby has been appointed lumber administrator.

Electric Propulsion of Ships*

Results Obtained With Electric Drive on the Jupiter—Installations for Battleships and Cruisers

BY ESKIL BERG†

UNTIL within the last few years, reciprocating engines were used exclusively for the propulsion of boats, but with the advent of the steam turbine and its almost universal use on shore, where, due to its high steam economy, small size, and light weight, it has practically superseded the reciprocating engine, the practicability of its use for the propulsion of ships began to be considered. Some of the reasons why the turbine is preferable to the reciprocating engine as a prime mover are as follows:

First: Because it gives simple rotation and admits the possibility of a large range of expansion. At present the best steam engines of the triple- and quadruple-expansion type cannot, on account of the size of the low-pressure cylinder, be made with an expansion ratio of more than 16 to 1 or 20 to 1. In the turbines, however, there are practically unlimited possibilities of expansion, depending almost entirely upon the temperature of the condensing water. A vacuum of 29 inches is not at all an unusual occurrence, and 29.5 inches is being recorded in some of the larger central stations during the winter months. What this means may be better understood when we consider the available energy of a pound of steam when it is expanded from boiler pressure to various degrees of vacuum.

200 pounds pressure to 24 inches vacuum......	220,000 foot-pounds
200 pounds pressure to 26 inches vacuum......	238,000 foot-pounds
200 pounds pressure to 28 inches vacuum......	265,000 foot-pounds
200 pounds pressure to 29 inches vacuum......	289,000 foot-pounds

In other words, a turbine can realize about 25 percent more of the energy of the steam than the reciprocating engine, which means a saving of 25 percent in fuel, size of boilers, etc.

The small size of the turbines is, of course, another very important item. Incidentally there are a great many minor advantages, such as saving of oil, attendance, ash handling facilities, etc.

When the turbine is considered for ship propulsion there are a few facts that must be borne in mind, namely:

High speed turbines are lighter, cheaper, simpler, and more economical than the slow speed turbine. Propellers, on the other hand, are, within well-known limits, confined to slow speeds for high efficiency. Turbines, therefore, when used for direct connection to the propeller shaft, must necessarily be designed to operate at a speed which is too low for the economical use of steam, and even then cannot be conveniently designed for a speed low enough to secure efficient propeller action.

It is therefore necessary, in order to obtain the advantages of the high speed turbine and at the same time to be able to use a low speed efficient propeller, to have some form of reduction gear between the propeller and the prime mover. This condition is what led up to the application of electricity to the propulsion of ships, to the mechanical reduction gear, and also to speed reduction by means of hydraulic transmission. Electric propulsion is best suited to very large, high-powered vessels, especially in cases where good economy is desired at two or more speeds, as in the case of warships. The reasons for this are as follows:

Electric Propulsion Best Suited to Large High-Powered Vessels

Electric transmission affords a very simple and practical means of speed reduction in almost any ratio which may be desired.

It affords a very simple means of reversal by a change of electrical connections without mechanical devices, complication of piping, valves, etc. Any desired reversing torque can be obtained without affecting the efficiency of the equipment in the forward direction.

In the case of battleships, the feature that is particularly important is that electric transmission affords means by which the ratio of speed reduction is changeable by simple electrical connections, thus making possible the economical use of the same apparatus, both under high-speed and cruising conditions.

Electric transmission makes it possible to use a plurality of cruising and generating units, so that damage to one or more parts will not disable the vessel.

With electric transmission, high steam pressure and superheat can safely be used, and the gain in fuel economy by its use is best shown by these curves. A steam temperature of 700 degrees is now successfully used in Europe, which with 500 pounds steam pressure would give a superheat of 233 degrees. Heat available for work would then be about 36.3 percent, whereas under ordinary steam conditions, say 200 pounds pressure and 50 degrees superheat, we have only 30.75 percent available, a net gain of 18 percent in fuel, which would more than compensate for any additional weight or cost of the electrical equipment.

Turbo-generators are now built with an efficiency of over 80 percent, which with motors of 95 percent efficiency and a boiler efficiency of 80 percent would produce a shaft horsepower-hour with 0.825 pound of coal (containing 14,000 British thermal units per pound) or 0.61 pound of oil (19,000 British thermal units per pound), the latter figure comparing favorably with Diesel engines when lubricating oil is taken into consideration.

The first electrically propelled boats in this country (outside of electric launches) were two fireboats in the city of Chicago, the *Joseph Medill* and the *Graeme Stewart*, which were equipped with electric propelling machinery in 1908. The second example of electric propulsion is the large United States collier *Jupiter*. Due to the wonderfully fine performance of this collier, which has now been in service for about four years, the Navy Department decided to install electric propelling machinery in the battleship *New Mexico*, which is now nearly completed at the New York Navy Yard, and the apparatus for which has recently passed all government tests at the Schenectady Works of the General Electric Company. The Navy Department has also decided to install electric propelling machinery in six other new battleships requiring about 33,000 horsepower each, and in five large battle cruisers requiring about 180,000 horsepower each.

The *Jupiter* is a sister ship of the *Cyclops* and the

* From a paper on "Propulsion of Ships," presented at a joint meeting of the Electrical Section of the Institute and the Philadelphia Section, American Institute of Electrical Engineers, October 11, 1917.

† General Electric Company, Schenectady, N. Y.

Neptune. They each have 20,000 tons displacement and a carrying capacity of about 12,000 tons of cargo. The principal dimensions are: Length, 548 feet; breadth, 65 feet; depth, 39¼ feet; draft, 27 feet 6 inches. The *Cyclops* is equipped with reciprocating engines and the *Neptune* with Parsons geared turbines (built by the Westinghouse Company).

In giving the General Electric Company the contract for the *Jupiter* equipment, a water rate of 13 pounds per shaft horsepower at 14 knots and 15 pounds per shaft horsepower at 10 knots was guaranteed. During her official trials the *Jupiter* maintained an average speed of 15 knots for 48 hours, with 7,152 horsepower delivered to the propeller shafts and a propeller speed of 116.72 revolutions per minute. The water rate as actually measured was 11.68 pounds per shaft horsepower-hour. Due to the fact that the steam pipe between the boiler and turbine was too small, the steam pressure at the turbine was only 168 pounds instead of 190 pounds, for which the machine was designed. Since the official trials took place a larger steam pipe has been installed and the water rate reduced to 11 pounds.

Performance of the Jupiter

During her 10-knot run the water rate was 12.31 pounds. It will be seen from this that the guaranteed water rates of 13 and 15 pounds were beaten by about 20 percent. The *Jupiter* is to-day, according to the government records, making a speed of 12 knots with a coal consumption of only 55 tons a day, which is a record about 35 percent better than any boat of her size afloat to-day. The *Cyclops* on her trials developed 14.6 knots with about 6,000 horsepower and a steam consumption of about 14 pounds, or about 25 percent greater than the *Jupiter*.

The *Neptune*, equipped with Parsons geared turbines, has just recently had her trials and the published results give us the following comparison with the *Jupiter* and *Cyclops*

	U. S. Naval Colliers		
	Cyclops	*Neptune*	*Jupiter*
Weight of propelling machinery only, tons...	280	150	156
Steam consumption at maximum speed, pounds per shaft horsepower-hour........	14.0	13.4	11.1

The third instance of electric propulsion is the new U. S. battleship *New Mexico*, which is now under construction at the New York Navy Yard. This installation provides conditions where the advantages of electric propulsion can be realized. The *New Mexico* is the largest and most powerful battleship which has been laid down by our navy up to the present time. She will have a displacement of 32,000 tons and a designed speed of 21 knots, requiring about 28,000 horsepower. The propelling machinery is, however, designed to deliver a maximum of 37,000 horsepower, and it is believed that this will give her a speed of 22 knots.

Electric Drive on the New Mexico

The equipment will consist of two turbo-generating units, four propelling motors (one for each shaft), switching apparatus, cables, instruments, etc. The contract also calls for two 300-kilowatt non-condensing, direct current turbo-generators, which will furnish excitation and power to drive the auxiliary machinery. As the General Electric Company was required to guarantee the steam consumption of the propelling machinery, including the auxiliaries, the greatest care was taken in their selection, and they are all to be electrically driven. The exhaust steam from the direct current generating sets which operate non-condensing will be used for heating the feed water, and any that may not be required for this purpose will be exhausted into the main turbine. The generators for the *New Mexico* are bi-polar alternators, and the motors are arranged to be connected for either 24 or 36 poles. For economic cruising at a speed of 15 knots or less, only one generating unit will be required with the motors on the 36-pole connection. For higher speeds the 24-pole motor connection will be used with both generators. One generator, however, will be capable of driving the boat up to a speed of about 19 knots.

Speed variations with either motor connection will be obtained by varying the generator speed, and a governor will be installed similar to that used with the *Jupiter* equipment.

The steam consumption guarantees as made to the government cover the total amount of steam used both by the main generating units and the auxiliaries, and are as follows:

Steam Pressure 250 *Pounds Gage at Throttle*	
10 knots..........	14.6 pounds per shaft horsepower-hour
15 knots..........	11.4 pounds per shaft horsepower-hour
19 knots..........	11.1 pounds per shaft horsepower-hour
Max. speed........	11.9 pounds per shaft horsepower-hour

Very heavy penalties are attached to these guarantees in case they are not met, namely, $25,000 (£5,140) per pound for the two lower speeds and $20,000 (£4,100) per pound for the two higher speeds.

At full speed the *New Mexico's* propellers will operate at 175 revolutions per minute, the lowest speed permissible within the space allowed. The propeller speed for the sister ship of the *New Mexico* with Parsons type turbines is 240 revolutions per minute, which, according to Captain Dyson, would indicate a propeller efficiency 9 percent worse than is expected on the *New Mexico*, and this difference would more than compensate for the electrical losses in the motors and generators.

In order to be able to correctly judge the relative economy of different methods of propulsion, it may be interesting to compare the water rate per effective horsepower, taking for examples of such different methods the battleships *Florida* and *Utah*, which are equipped with Parsons turbines; the *Delaware*, which has reciprocating engines, and the *New Mexico*, with electric drive.

	Propeller Speed	Water rate per effective horsepower per hour. 12 knots	19 knots	21 knots
Florida	328	31.8	24.0	23.0
Utah	323	28.7	20.3	21.0
Delaware	122	22.0	18.7	21.0
New Mexico	175	17.3	15.0	16.4

The guaranteed weight of the propelling machinery for the *New Mexico* without the auxiliaries is 530 tons, with a penalty of $500 (£102.5) per ton for any excess over this amount. The estimated weight of the Parsons turbine equipment for this vessel was 653 tons.

The contract price for the *New Mexico* machinery was $431,000 (£88,500), and the Navy Yard estimates show that a saving of $200,000 (£41,000) will be effected by using this equipment instead of the Parsons equipment as originally contemplated.

Electric Propulsion for Large Battle Cruisers

These vessels are designed to have a speed of 35 knots, at which speed they will require about 180,000 horsepower. There are four propellers operating at 250 revolutions per minute at maximum speed.

The installation proposed for these ships consists of four high speed turbo-generators, each having a capacity of about 35,000 kilowatts. On each propeller shaft there will be two independent induction motors, each having a capacity of 22,500 horsepower. The switchboard will be provided with an arrangement by which any combination of generating units and motors can be used, and starting, stopping, and reversing can be instantly done by movement of a lever. All changes of connections are made

on dead circuits, so that there can never be any big rushes of current to strain the apparatus. Safety devices are also provided so that any unbalancing of current will open the circuit of that particular unit in which it occurs.

The total weight of the complete equipment for one of these vessels is about 1,800 tons, of which the turbines alone weigh about 350 tons.

Ljungstrom System of Electric Drive

That electric propulsion can also be profitably applied to a small boat is proved by Mr. Ljungstrom, in Sweden, in the case of the small coastwise steamer *Mjolner*, which is only 225 feet long, 56 feet beam, and 15 feet draft, requiring 900 horsepower. Stockholm's Rederiaktiebolajet Svea decided to build two sister ships, the *Mimer* and the *Mjolner*. The *Mimer* was equipped with triple expansion engines, and Mr. Ljungstrom guaranteed a saving of 30 percent in fuel with his method of electric propulsion in the *Mjolner* over the *Mimer* equipped with engines. The boats have now been built and tested, and the electrically propelled boat showed a saving of 42.3 percent in fuel consumption. This is indeed a remarkable record, but may be partly explained by the increased efficiency of the boiler plant. For his electric drive Ljungstrom uses 218 pounds steam pressure and 235 degrees superheat, and this alone would effect a saving in coal over the *Mimer* of about 15 percent.

In this boat Ljungstrom uses two 400-kilowatt turbines running at 7,200 revolutions per minute, generating 3-phase, 120-cycle current at 500 volts. This current is used to drive two induction motors which are geared to the main propeller shaft. The motors run at 900 revolutions per minute and the propeller shaft at 90 revolutions per minute. All of the auxiliaries are electrically driven, which affords another appreciable saving.

Mr. Ljungstrom has done some wonderfully fine engineering in connection with this equipment and has combined electric propulsion with mechanical gearing, which is a great step forward.

Marine Terminals for Inland River Cities Located on High Ground

Principles Governing Construction of Efficient River Terminals—Design and Equipment—Mechanical Co-ordination Between Water and Rail

BY H. MC L. HARDING*

Many of the terminal cities and towns of the Mississippi River and its tributaries, also those of the Pacific and Gulf coasts, are situated on high ground far above the ordinary river levels. This is on account of the great and sudden rise of the rivers, varying from fifteen to sixty feet. These high-lands in the interior are generally called bluffs.

On account of this height and of the steepness of the banks, the transference of freight between the river and the city in the past has been difficult and has resulted in greatly reducing the volume of river transported freight. Unless there is a change in river terminal methods, the railway freight stations will be preferred by the shippers and consignees.

Deepest Water Near Bluffs

Cities are not often located on low lying ground on account of liability of overflow, but upon these bluffs. Near the foot of such bluffs, especially where there is low land on the other side of the river, there is generally the river-channel, where is the deepest water in the river, opposite the city.

From the various illustrations, it will be noticed that where their are steep banks the horizontal distance from the top edge of the bank to the natural or dredged channel is in most cases less than at seaports, so that the width of the river quay is even less, that is, the "built out" section. As barges or other inland river vessels are of small draft, berths with sufficient depth can be found near the shore.

Quays Preferable to Piers

Where possible, quays are preferable to piers in regard to the initial investment and the cost of maintenance. They are less liable to injury from ice or impact of vessels, and greater speed of discharging and loading is possible.

Drayage Difficulties

It is necessary for the load to be raised to the top of the bank in any event, whether by drays, man power or inclines. Free vertical freight movements are much quicker in operation than any other method. That the loads must finally reach a certain elevation should always receive consideration in the designing.

In some cases, in ancient days, wharves of different stories have been constructed, the idea being to unload at different levels at different heights of the river.

Peculiar Designs

Where this design is consented to, it is generally necessary to construct ramps or steep inclined roadways to these different levels which are flooded at certain seasons.

The levels and roadways are expensive to construct and to maintain, adding by the increased number of freight movements on the different floors to the operating costs. Rehandling methods are not advisable.

Why there is not one direct vertical lift from the barge itself to the upper level is difficult to understand. The height of the bank is no obstacle to speed, and the lifting height adds little indeed to the expense of operation.

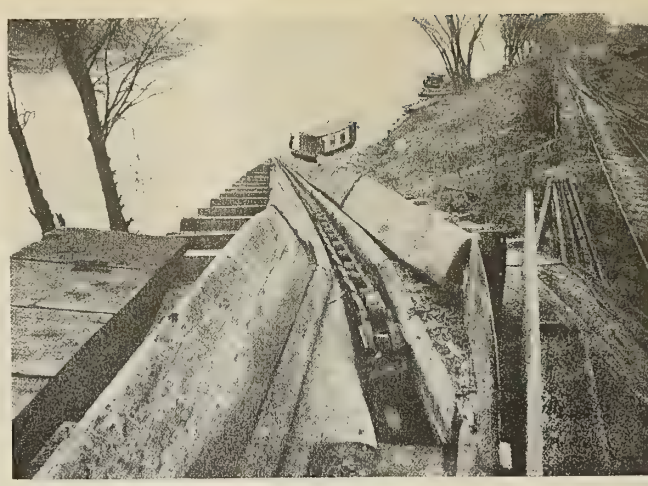
The few quotations from the Government Report, House Document 226, 63rd Congress, pages 980-981, will make clear some of the difficulties of past terminal operation.

Grades and Condition of Roads to Terminals

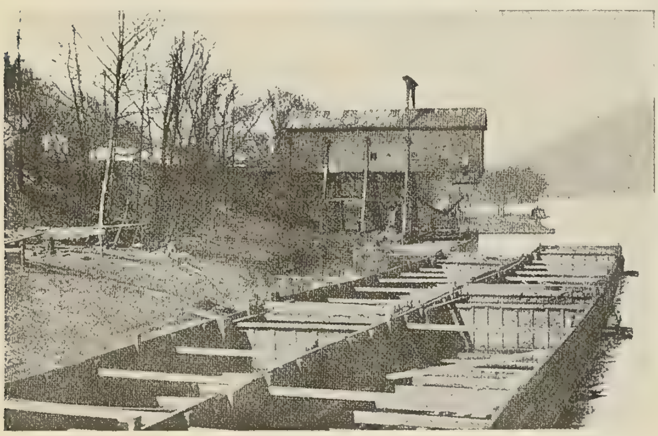
Grades even on a paved road over six percent are difficult to surmount. The terminal approaches or roads are generally in wretched condition. The descriptions of grades refer to different inland river terminals.

* Consulting Engineer, New York. Terminal Engineer, Upper Mississippi River Improvement Association. Terminal Expert for the State of New York on Barge Canal Terminals.

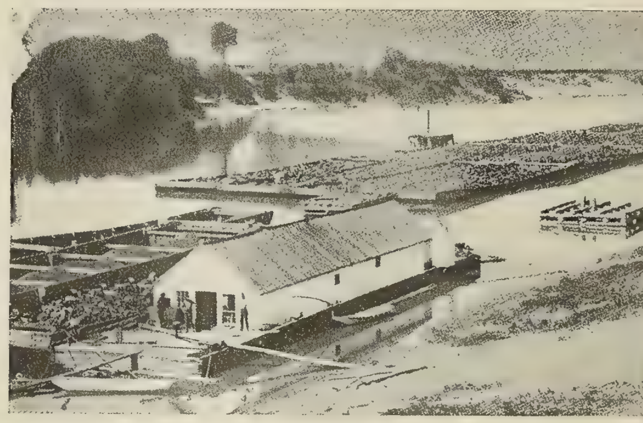
Coal Tipple, the Forerunner of Permanent Type of Marine Quay, Built into River and Protected from Ice by Clusters of Piles



Inclined Railway Tie Hoist Requiring Two or Three Handlings. With Jib Cranes Only One Handling Would be Required



Loading Barges at Coal Tipple



Type of Existing River Terminal with Wharf Boat, Ice Pier and Road Approaches

Grade of road 20 percent, not paved, in ruts, muddy in rainy weather.

Grade 20 percent, very muddy if used in wet weather.

Grade 13.8 percent, very muddy, form ruts.

Grade 15.3 percent, not room at bottom to turn.

Grade 22 percent, muddy.

Grade 10.5 percent, poor condition.

Grade 18 percent, clay—very bad condition.

Grade 12.5 percent.

Grade 11.4 percent, poor roadbed, little better than a ditch.

Grades at other places, 17.7, 13.7, 12.3, 17.2, 16.8 percent.

These grades are horse-killing and gasoline- (petrol) consuming.

The above are the reports of the Government engineers.

Low Water Most of the Year

During most of the year the river is at the low level and the inbound river freight must be carted up these poor roads. In larger cities where there are paved levels, the hauling of heavy loads up the levee grades is not easy and very expensive.

It is interesting to note that in many engineering reports too little attention is given to speed of transference, that is, the tonnage capacity per linear foot which depends upon the operating speed.

Speed of Transference Essential

There might be by some form of rope haulage and winches and a platform a fair means of surmounting the bank for a small tonnage of miscellaneous freight, chiefly limited, however, by the congestion at the top of the incline or the necessity of having a large gang of men to bring the freight from various portions of the boat to the foot of the incline and away from the top of the incline for the assorting, distributing and tiering. With one incline there are many idle minutes.

Terminal Congestion

In case there are large and prosperous communities with the earnestly desired river-transported freight, there immediately arises great congestion, a small army of men being required with long detention of the barges. The increased unnecessary terminal expense is more than the saving in river transportation over rail.

The above kind of terminal designing is not advisable either from the standpoint of first cost or expense of operation.

Elevation of Banks No Obstacle

With a correctly designed quay equipped with such facilities as traveling gantry jib cranes of great speed transferring capacity and adapted to transfer and handle every kind of freight, the height of the bank is no obstacle to securing most satisfactory commercial results and the objection to high banks or to the rise of the river is eliminated.

Probably the average height of hoisting would not exceed thirty feet with a maximum of not above seventy feet.

The standard specifications for the unusual gantry jib crane at steamship terminals require a lift of 80 feet with a load of from two to five tons, at a hoisting speed of

200 feet per minute, and it will be seen that the average of lift at these river terminals is far below the customary height of lift at sea ports.

At 200 feet per minute hoisting speed, thirty feet more or less, requiring about ten seconds, is a negligible item in time or expense of transference. As the volume of freight increases, more cranes can be added up to the linear capacity of the quay.

Designs

The type of the substructure and its material will depend upon the volume of freight, the importance of the terminal and the appropriation available. To determine the exact design and kind of construction a careful engineering study on the ground is necessary.

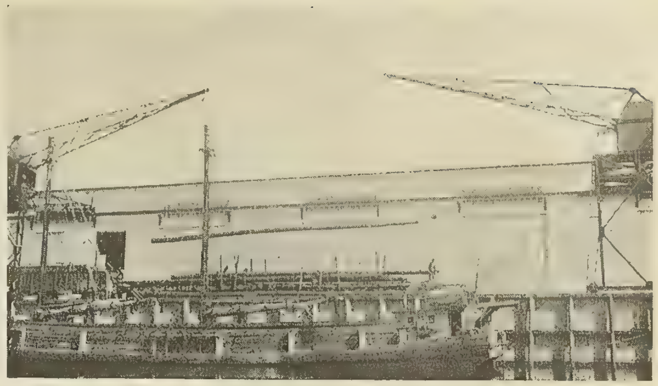
As explained later, the water frontage of a quay may be a unit 300 feet long and when properly equiped will have an annual transferring capacity of about 100,000 to 125,000 tons. In some cases, therefore, the quay frontage can be two hundred feet in length and possibly less.

The Terminal unit comprises the quay, the railway tracks in front of and behind the shed, the space—some thirty-five feet in width—between the shed and quay frontage, served by overhead traveling jib gantry cranes, the shed of sufficient height with internal loop cranes for assorting, distributing and tiering freight. There should be a warehouse forty to sixty feet to the rear of the shed controlled by the terminal authorities even when privately owned.

Where the tonnage of freight is small or mostly of one commodity, and especially when privately owned, various devices have been employed, some of which are herein

Rear Face of Quay Wall Built Out Into River. Space to be Filled with Sand from River. Height of Wall 16 Feet

Space Behind Wall Nearly Filled. End of Wall Temporarily Closed by Bulkhead on Piles. Depth of River at Low Water 26 Feet



Modern River Terminal. Front of Quay Wall Protected by Fenders. Gantry Cranes Used for Transfer of Freight from Barges to Cars on Quay or Into Shed

illustrated, and which for the purpose intended are excellent.

Types of Machinery

If, however, there is to be established a public terminal where there are many different commodities of various sizes and descriptions to be transferred and where the speed transference and handling is the most important feature of the terminal, then it is evident that where there must be such machinery which, by a continual succession of movements, will rapidly and without manual rehandling take the freight from its exact place in the river barge and by mechanical co-ordination deposit it in its proper place at the elevation of the top of the bank. If for delivery within forty-eight or seventy-two hours, it is placed in the shed, or in the warehouse if for long storage, and from the shed into the warehouse after seventy-two hours. Similarly, freight should be stowed in the barge with no rehandling.

No Manual Rehandling

There should be no man-handling on the barges, that is, moving the freight from one place in the barge to another, or manual rehandling on the top-level from one point to another. This should be done mechanically.

Terminal Principles

Principle No. 1.—There should be possible free vertical movements of freight to and from its place in the barge. The level of the quay should be about the same as the top of the bank. Any covering of the barge should be constructed so as to be removable in order not to interfere with the vertical movements of the freight.

It is not sufficient merely to unload the barge upon a wharf boat, but it must be taken by the machinery to the upper level of the river bank. It is quicker, easier and less expensive to raise the load vertically to the required level by one movement and swing into the shed or on to the car than to unload upon a houseboat, platform or incline, and then by other means, as drays, man power, or inclines raise to the height required and then move again by manual labor.

The investment is reasonable, if the terminal be correctly designed and can be made proportional to the size and needs of each community.

Principle No. 2.—Freight should be lifted or lowered vertically to or from any part of the barge by such mechanism as will take from the boat and place within the shed or from the shed into the boat.

A far larger proportion of the freight than is usually expected is commerce or through freight, that is, freight

(*Concluded on page 487.*)

Letters from Marine Engineers

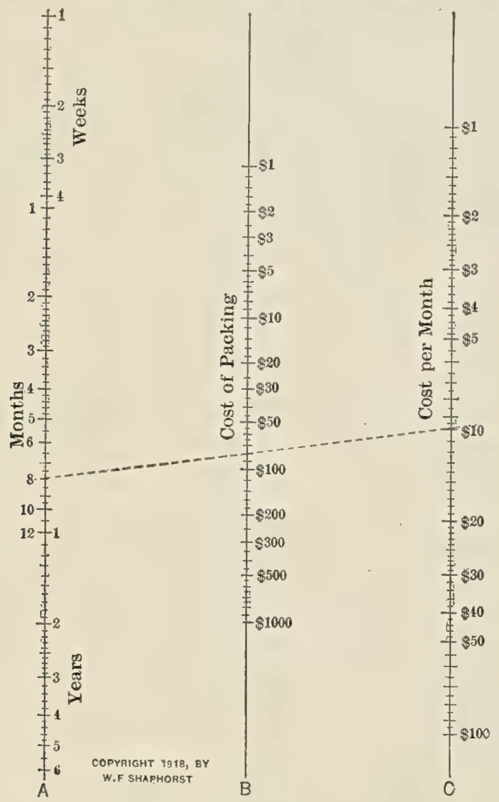
Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Chart for Comparing Costs *

This chart will be found handy for determining the cost per month of the various materials used in and about the engine room. It is a good thing to keep tab on supplies purchased so as to know when bought and when replaced. Then by dividing by the number of weeks, months, or years of service the cost per month is found and the engineer can decide whether or not to purchase the same thing again.

For example, let us assume that a certain engineer bought what he thought was a good grade of packing.



Cost Chart

He packed his pumps with it, and found the total cost to be \$80. After eight months the packing was worn out and had to be replaced again. What was the cost per month? That is an easy one, and can be done mentally, but just to show how the chart works I have selected an easy one for a starter. The dotted line drawn across the chart shows that you merely lay a straightedge across connecting the \$80 (column B) and the 8 (column A) and the extension of the line cuts column C at \$10. In other words the packing costs \$10 per month.

The engineer now sees a given packing advertised which, it is claimed, will last much longer, but its first cost is more. He might naturally say to himself without figuring at all, "That costs too much. I can't afford it. Guess I had better use the same old packing." However, the engineer leisurely lays a straightedge across the chart connecting the claimed length of life (two and one-half years) with the estimated cost (\$200) and he finds to his surprise that such a packing would cost him a trifle over \$6.50 per month. He rubs his eyes. He tries again. He thinks there must be something wrong with the chart, and "dopes it out" longhand, only to find that the chart, after all, is pretty accurate. As a result he purchases the packing which costs more at first but considerably less in the long run. It is evident, therefore, that the chart is a valuable one and it would be well to keep it in a handy place whenever looking through advertisements or whenever purchasing supplies.

The chart applies not alone to packing, but to anything that wears out in a short time. Gaskets, cylinder oil, belt treatment, belts, valves, grate bars, etc., all come under this head. Even though the exact cost may not be given in column B it is a simple matter to shift the decimal point in such a way that the correct answer will be obtained in column C. Thus, if you bought only three cents' worth of waste, and if it lasted four weeks, you would connect the four (column A) with the \$3 (column B) and the line cut through the \$3.50 in column C. It is evident that in writing three cents with a dollar sign in front of it, it becomes \$.03. The decimal point is, therefore, shifted two places to the left in column B, and at the same time the decimal point must be shifted the same number of places to the left in column C, which gives us 3½ cents per month as the answer.

The range of the chart, it will be noted, is wide enough to care for every ordinary case of supply purchasing.

New York. W. F. Schaphorst.

* Copyright, 1918, by W. F. Schaphorst.

Cargo Record

A London newspaper, *The Daily Express* of June 27, 1918, gives publicity to the following:

"A new record has been established in the rapid discharge of cargo. A steamer laden with 6,200 tons of iron ore was discharged in 45½ hours, giving an average per crane of 40½ tons per hour. In one period of twenty-four hours no less than 3,366 tons was discharged."

It is more than probable that this is by no means a world's record. When the writer was trading to the Baltic port of Lulea, a very large vessel of Dutch nationality, specially built for the purpose, used regularly to ply between Rotterdam and Lulea. Her appearance resembled a bedstead more than a ship, for she had 12 double derrick masts and 24 winches; it may have been more. Her tonnage was very large and her rate of discharge must have been correspondingly high.

The preparations now being made at the new South American port for loading iron ore for the United States must, if report be true, be considerable. A recent account states that 16,000 tons can be loaded in a very few hours.

It is needless to add that discharge is always slower than loading, for at Lulea 10,000 tons could be loaded in 24 hours, a matter of fifteen years ago. Nor is there any need to labor the point that rapidity of terminal

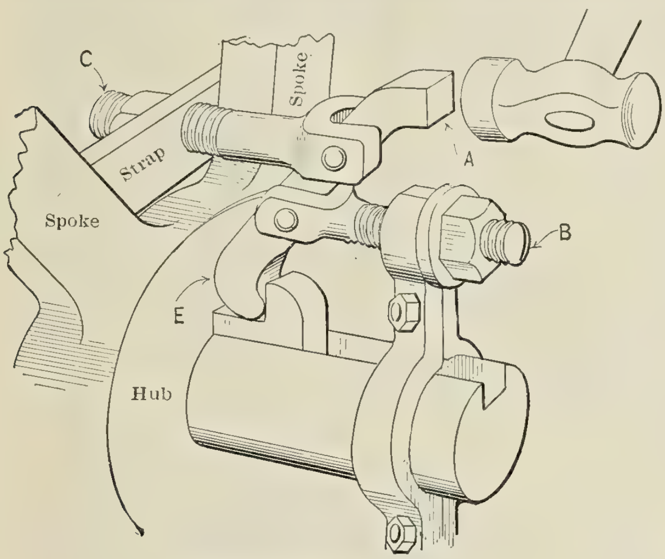
turn round is equivalent to a large addition to available tonnage. This was the first problem tackled over here when tonnage became restricted.

The absolute record for discharge as for loading must be oil, for the facility and ease with which it can be put in and taken out must place it first on the list.

However, rivalry in the matter of discharging is of considerable interest at the moment, hence these remarks from London. A. L. Haas.

Key Extractor

While on a recent visit aboard an ocean liner I came across a rather strange sort of key extractor. The second engineer's crew was doing a bit of overhaul work on the ice machine, and at the time I arrived they were taking off the large fly-wheel. My attention was at once attracted to



Method of Extracting Key

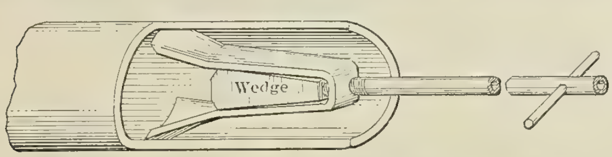
the device they were using to pull the key. A rough sketch of it is shown. The engineer in charge devised it and explained its merits. The sketch is self-explanatory. A hand hammer is used to hit jarring blows on *A* when the tension is taken up on the two bolts, *B* and *C*. After the key is started, distance pieces are used at *E*.

The hub of this fly-wheel set up flush to a shoulder, the key was therefore only accessible from the one end.

This device is passed on to show how some fellows contrived to rig up tools to get around stubborn jobs. It works excellently and seems worthy of describing to the readers of Marine Engineering. C. H. W.

Cow Mouth Scraper

The boys called this a cow mouth flue scraper; but be that as it may, its name is not important. This little tool is



Partial Section of Tube, Showing Action of Scraper

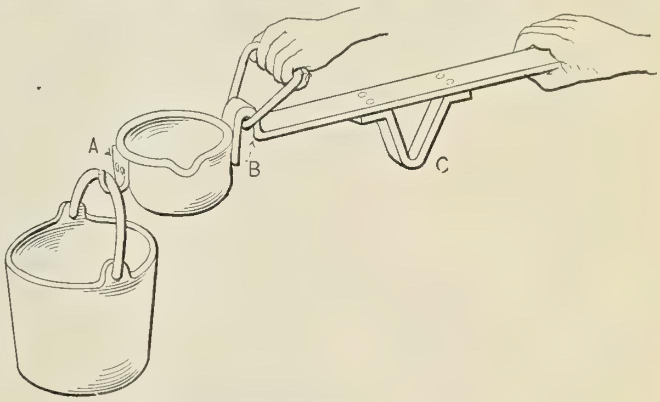
cheaply and quite easily made from a piece of pipe for the handle, a bit of bar stock for the wedge, and an old 14-inch flat file for the scraper.

The sketch tells the tale of how it is made but a few words may help to make it clearer. Cut the tang off the file, heat it cherry red and draw both ends of the file down wedge shape. Spread so as to give the bell shape by forming them over the horn of the anvil. Drift a hole through the center of the length of the file for the handle, then form it to the U shape, being guided by the diameter of the tube that you are making the scraper for. Next make a wedge and tap one end for a stud or screw. By means of this, the diameter of the front edge of the scraper is governed. Make and fit the piece of pipe for a handle and the tool is ready.

Fireman.

Handy Babbitting Ladle

The sketch shows how the ordinary babbitting ladle may be made a great deal handier for the work. By riveting a hook on as indicated at *A* and bending a part of the handle as shown at *B* to permit the use of a triangle made of wire for lifting the babbitt ladle when hooked on to the



Sketch of Ladle Showing Attachments

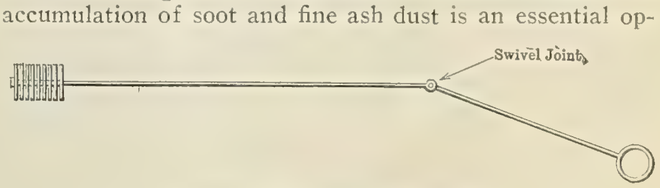
melting pot, as shown, and riveting a foot, as shown at *C*, to the handle, the alterations are complete.

When carrying any quantity of hot babbitt in a large ladle, the triangle used at *B* permits it to be done with greater ease. When the job of pouring is complete there is sometimes a small amount of babbitt left in the ladle, and if it is desired to set the ladle down, the foot *C* permits this being done without it tipping and spilling.

Machinist.

Adapting Flue Scaper Handle for Restricted Locations

The scraping out of boiler tubes in order to remove the accumulation of soot and fine ash dust is an essential op-



Jointed Flue Scraper Handle

eration in securing good boiler economy, but where the space is restricted and where it is impossible to use the long handle scraper usually employed, the matter is liable to be slighted or overlooked.

An exceedingly simple method of overcoming this obstacle is by means of a handle made as shown in the attached sketch, from which it will be noted that a swivel joint is made about half way down the handle so that the

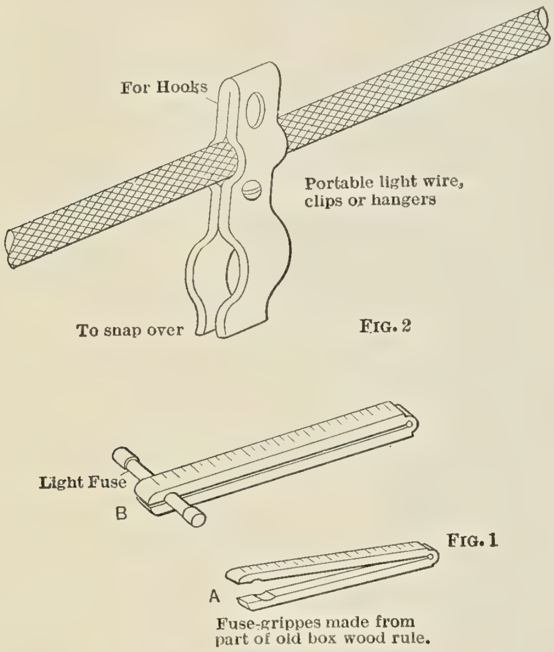
scraper can be manipulated in the least amount of space, since as soon as one section of the handle is out of the tube it can be bent over, allowing room to pull the following sections out.

While the sketch shows but one joint, if the conditions are very restricted, two or more sections can be used.

Philadelphia, Pa. W. A. Lailer.

Two Electrical Kinks

Fig. 1 shows a fuse gripper made from part of an old boxwood rule. The sketch is self-explanatory. Two legs of the rule are all that is necessary. A groove for the round part of the fuse is cut as shown at *A*, and used as shown at *B*. This will be found very handy and save many a shock to the system.



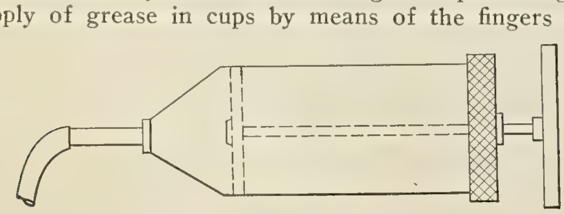
Fuse Gripper and Hanger

Fig. 2 shows a very neat and useful brass clip or hanger for portable electric light wires. These are made from ⅛- and 1-inch flat brass stock, and permit the slack of the light wire to be hung up or snapped up by either side of the device. This contrivance will be found to save a great deal of trouble in the use of a portable light aboard ship.

Electrician.

Convenient Method of Feeding Grease Cups

The customary method of feeding or replenishing the supply of grease in cups by means of the fingers or a putty knife or stick is at the best an unsatisfactory and inconvenient one, usually smears up the surrounding parts and also involves the loss of not a little grease. Where a grade of grease is used that is not too thick or gummy the work can be done more neatly and much quicker and with a saving in grease by making use of a grease gun, as shown roughly on the attached sketch.



Grease Gun

The cylinder of the grease gun can be filled before starting on the round and then by merely pressing down the plunger a supply of grease can be inserted into each cup. Such a grease gun can be made of an old oil squirt gun or can be easily made of some brass tubing.

A gun about 2½ inches or 3 inches diameter will be found most satisfactory for general purposes, the length depending upon the quantity of grease used and the space limitations.

Philadelphia, Pa. W. A. Lailer.

Long Jaw Toggle Clamp

This is a rather odd type of clamp, but it is adaptable to many kinds of work aboard ship, and when one gets spare time to make it from odd stock it is not very expensive. There are two of them in the shop kit of one of our repair vessels in the Navy, and the machinist's mate in charge, who made them, says that they have proven very useful.

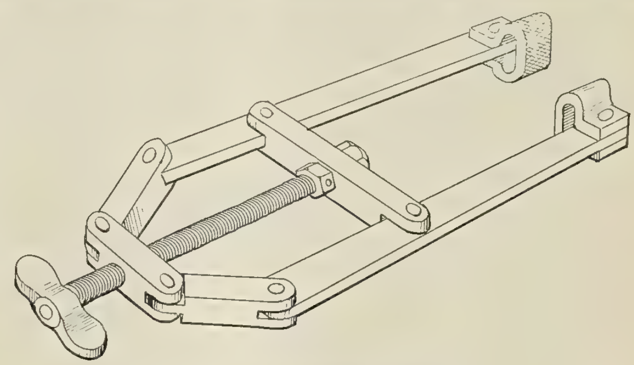


Fig. 1.—Toggle Clamp

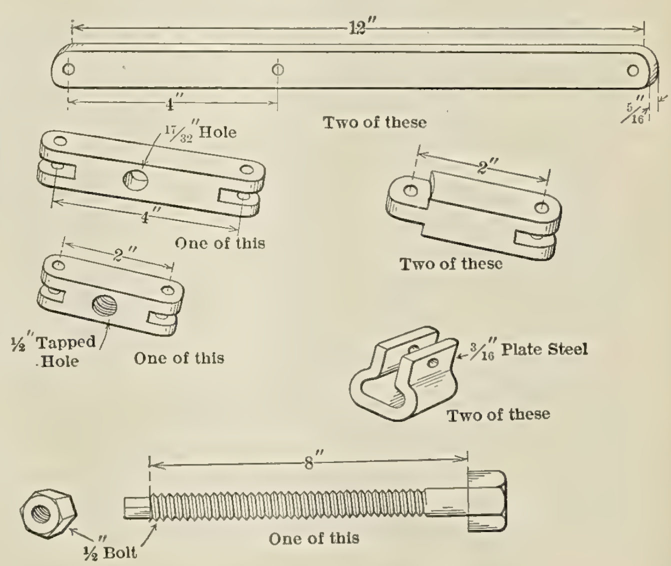


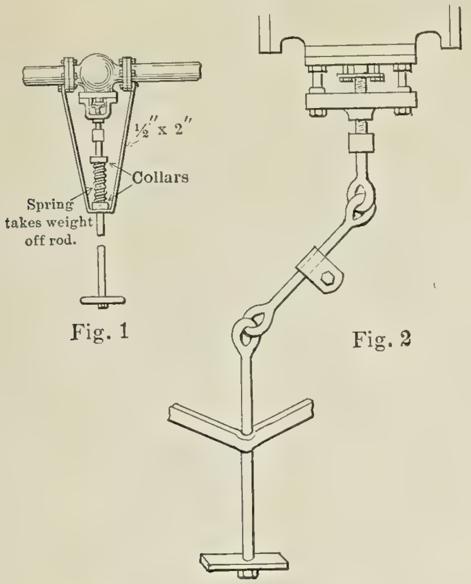
Fig. 2.—Details of Toggle Clamp

All the dimensions are given in the detail drawing, as shown in Fig. 2. The whole thing should be made if possible from good stock. It will last longer and give better service.

Concord, N. H. Chas. H. Willey.

Reach Rod Kinks

These are two ideas that are used by several ships in our navy for reach rods on valves that are up overhead out of reach. The ideas are common, but I have visited many ships where they have not worked such kinks in,



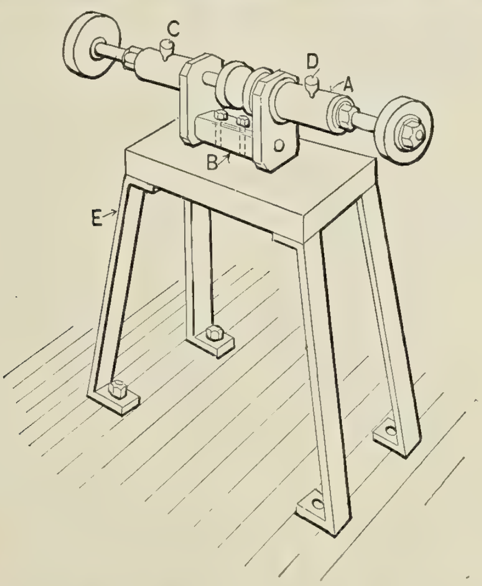
Universal Joint Reach Rod

and are content to climb up upon the pump or engine to reach a valve, or where they do employ reach rods the whole weight of the heavy rod hangs on the valve stem, wearing its threads at each operation.

Machinist Mate.

Buffing Wheel

While on a recent visit to a brother engineer's vessel he showed me a novel buffing and emery wheel constructed from a discarded blower engine crankshaft, one that had



Emery and Buffing Wheel Mounted on Old Crankshaft

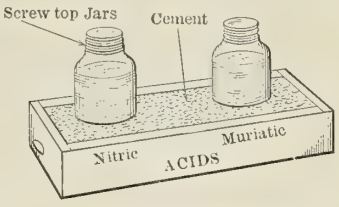
become badly scored and unfit for further use. The sketch shows how he had converted it from uselessness to a very handy machine.

Both the crank pin and shaft journals were hollow. Several anchor holes were drilled in the shaft journals; then the inside of the shaft *A* was poured full of babbitt. A shaft for the emery and buffing wheel with necessary collars, nuts, washers, and a pulley was made. The babbitt was bored for this spindle shaft, and the crank pin *B* was drilled for two securing bolts; oil cup holes *C* and *D* were drilled, and the stand *E* made. This completed the job and gave a unique and useful machine.

Chief Engineer.

Two Kinks

Both of these sketches talk for themselves, so little need be said except that they were picked up on visits to the other fellow's plant. It pays to exchange ideas and



Safety First Non-tipable

Safety First

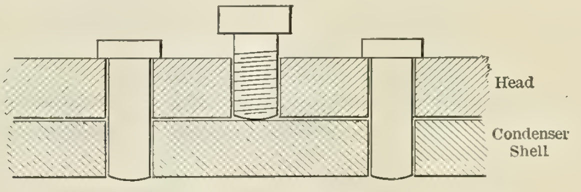
Safety First Kinks

experiences. A visit to a brother engineer's plant may put a few more ideas in your head and dollars in your pocket—at any rate, visiting in spare time pays.

W.

An Aid in Removing Condenser Heads

Very frequently after condensers have been in service for some time the gasket joint between the shell and heads becomes cemented together very tightly and frequently trouble is encountered in loosening the head after the bolts have been taken out. The usual practice of in-



Arrangement for Loosening Condenser Head

serting a chisel between the head and shell destroys the gasket and produces unnecessary strains on the apparatus.

A very simple arrangement for loosening the head is to tap into the headpiece—one on each side—a 1-inch tapped hole, threaded, to take a round ended bolt. After the head bolts have been loosened and taken out the most tenacious joint can usually be broken by inserting the one-inch bolts in each of the four tapped holes and drawing them up evenly turn by turn.

This represents a rational method of doing the job and makes it worth while because of the saving of the difficult gaskets used on the condenser heads.

Philadelphia, Pa. W. A. Lailer.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY H. A. EVERETT

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number if from examination for grade of chief, and by a dagger (†) if from examination for other grades.

Formula for Babbitt Metal

Q. (979).—Can you give me a formula for a babbitt metal which does not use as much tin as the present tin base babbitt used in marine bearings. The acute shortage of tin makes it desirable to use as little of it as possible provided we can get a satisfactory bearing with less.

A. (979).—The following has been recently used in bearing of marine engines of piston speed not exceeding 700 feet per minute: lead, 79 percent; tin, 9 percent; antimony, 12 percent.

Development of Stern Plating Around the Cant Frames

Q. (984).—Kindly publish in your question and answer column the most modern and correct method of developing plates around stern cants?

A. (984).—The stern plating around the cant frames above the lower knuckle line is cylindrical in form, that is, the surface is generated by a cylinder whose axis remains parallel to the center line plane of the ship. By assigning this form the plating is developable and the true shape of the plates that go to make up the overhang can be determined.

Usually the form of the stern is fixed by the straight rake line *A S* (Fig. 1), the knuckle line and the rail line. The rail and knuckle line in the sheer and half breadth plan are faired by the buttocks *B*-1, *B*-2, *B*-3, *B*-7. It will be observed the buttock lines between the rail and the knuckle line in the sheer plan are straight and parallel to the rake line *A S*; this is because the surface is generated by a cylinder with axis parallel to the center line.

The stern frames are then transferred to the half breadth plan; these are usually straight lines. The stern may now be cut by a plane at right angles to the rake line. The trace of this plane in the sheer plan is a straight line *A B*. The true shape of the curve of intersection of this plane with the hull is obtained by swinging it down into the horizontal; this is shown by swinging arcs with *A* as a center and the intersection with each buttock as a radius. These points can then be projected into the half breadth plan on their respective buttock lines and the true shape of *A B* is obtained as indicated. Next revolve the rake line *A S* into a horizontal plan to the position *A S′* and imagine the line *A B* together with the whole of the stern plating revolved into the vertical. In the new position *A B* will appear as a straight line touching the paper only at the center line. Its true form is given by the line from *A′* to *B′* and it is possible to measure around it and take its girth with a flexible batten, spotting off the various buttock lines. The batten is then laid off straight along the line *A′B″* and the various buttocks spots transferred. These points are the positions of the buttock lines when the stern plating is flattened out, and lines may be drawn through these points parallel to the center line. The expanded rail and knuckle lines are then transferred to the half breadth plan by measuring in the sheer plan the distances of the rail and knuckle from the line *A B* on each buttock. These are transferred to the half breadth plan on lines *B′*-1, *B′*-2 *B′*-7, and curves are then drawn through the points so obtained.

Next draw on the expanded stern the lines of the stern frames and transom. The rail and knuckle lines in the half breadth plan are girthed with a flexible batten and the positions of the stern frames and transom are spotted upon it. The points are then transferred to the expanded rail and knuckle line, lines drawn between the points will show the stern frames and transom.

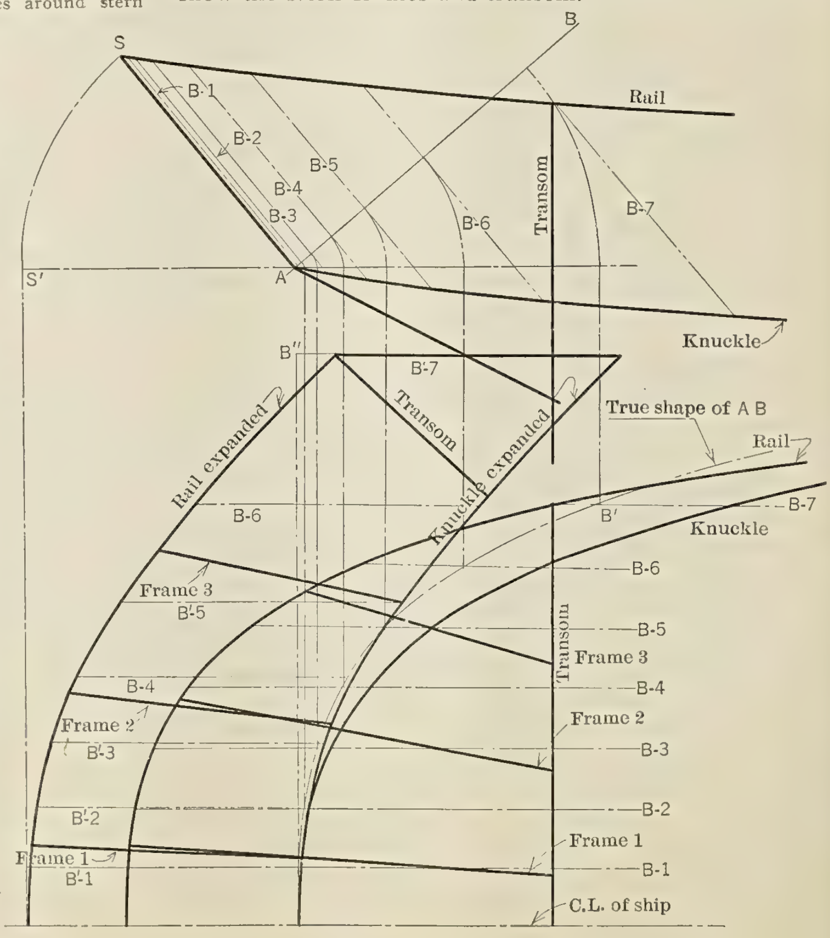


Fig. 1

Having obtained the expanded form of the stern the various plates may be marked off and templates made for each plate. The shape of the plate is such that it is only necessary to roll in one direction.

Size and Weight of Scotch Boiler

Q. (974).—Can you give me rough rules for estimating the size and weight of a Scotch boiler to supply an engine of known indicated horsepower?

A. (974).—An approximate estimate is to allow about 0.52 to 0.59 indicated horsepower per cubic foot of boiler for forced draft conditions and 0.48 to 0.50 indicated horsepower per cubic foot for natural draft conditions. For example, an engine of 1,500 indicated horsepower would need about $1{,}500 \div .59 = 2{,}540$ cubic feet of boiler for a forced draft plant, or a boiler about 16 feet 4 inches diameter by 12 feet length approximately.

The weight of boilers runs about 45 to 50 pounds per cubic foot.

Marine Terminals for Inland River Cities Located on High Ground

(*Concluded from page* 481.)

between the barge and the railway car for interior points. It should therefore be possible to transfer freight directly by machinery from barge to car and from car to barge. To do this there should be railway tracks between the shed and the quay wall, served by the same mechanism which hoists from or lowers into the barge.

As this freight is often for several cities, there should be placement tracks nearby for a number of cars.

Principle No. 3.—There should be direct mechanical co-ordination between water and rail.

The function of the steel shed is short-holding and of the concrete warehouse, long storage. There should be open areas for coarse freight (that which is not affected by the weather) and for bulk material. This coarse freight and bulk material should be transferred by the same mechanism which transfers package freight and miscellaneous goods.

All the cubical contents of the shed and the unshedded areas should be served by overhead machinery which operates in unoccupied air spaces, not requiring floor space to be reserved. Longitudinal movements of freight of every description, even far to the right or left beyond the finished quay wall, can be performed by correctly adapted machines. By such designing the length of the quay wall can be made less.

Conclusions

First: Free vertical freight movements should be possible. The elevation of the bank above the river makes little difference in the time or cost of operation.

Second: Machines of a universal type, capable of transferring any kind of freight, should be provided, whereby the freight can be transferred vertically, the number of machines being proportional to the freight tonnage.

Third: The cost of a terminal quay of modern standard design and facilities for transferring a given tonnage of freight within a given time will require an investment of about one-half than usually required and can be constructed in less than one-half the usual time.

Fourth: The design of the river terminal is an engineering problem, a co-ordination of terminal principles and the adaptation of mechanical appliances.

Fifth: The complete terminal should be constructed by units, that is, each unit with a linear frontage equal to the length of the longest barge. Each unit should be a complete terminal with all the terminal elements and capable by itself of earning a net income on the terminal investment.

NEW BOOKS

Practical Marine Engineering. Sixth Edition. By Rear Admiral C. W. Dyson, U. S. N. Size, 6 by 9 inches. Pages, 1,067. Illustrations, 438. New York, 1918: Aldrich Publishing Company. Price, $6.

In the several editions which have been published since this book was first written in 1901 by Dr. W. F. Durand, at that time professor of naval architecture and marine engineering at Cornell University, numerous changes have been made and much new material added. The fourth edition, published in 1917, was thoroughly revised and brought up to date by Rear Admiral C. W. Dyson, of the Bureau of Steam Engineering, United States Navy. Since the fourth edition was published the United States has entered the war and the demand for trained engineers for operating the great American merchant marine now under construction for the prosecution of the war has been so urgent that it has been found advisable to enlarge this book still further and include information not only regarding the construction, installation and operation of propelling machinery and engine room auxiliaries but also regarding the deck machinery of a merchant vessel. In the new edition a new chapter has been added on miscellaneous machinery, which describes the construction and operation of steering engines, windlasses, boat cranes, anchor engines, ash hoisting engines, towing engines, ventilating, heating and cooling apparatus, sirens and whistles, fire extinguishing and fumigating appliances, reducing valves and regulating valves. The sixth edition of the book, therefore, covers completely every branch of the work within the scope of a licensed marine engineer. It is written with the special object of furnishing aid for applicants for marine engineers' licenses. Questions similar to those given in examinations of applicants for marine engineers' licenses are appended at the end of each chapter, with references to the pages containing the information necessary to answer such questions.

Concrete Engineers' Handbook. By George A. Hool, S. B., and Nathan C. Johnson, M.M.E. Size, 6 by 9 inches. Pages, 885. Numerous illustrations. New York, 1918: McGraw-Hill Book Company, Inc. Price, $5.

This handbook presents in concise form what the authors consider the best of present-day knowledge concerning concrete and reinforced concrete. It contains complete data and details, with numerous tables and diagrams, for the design and construction of the principal types of concrete structures. Owing to the very recent application of concrete to shipbuilding, the only reference to concrete barge and ship construction in the book is a brief extract from a report of the joint committee of the American Concrete Institute and the Portland Cement Association published last fall.

The Strength of Ships. By J. Bertram, A. M. Institute, C. E. Size, 4½ by 7¼ inches. Pages, 290. Illustrations, 114. Tables, 31. New York, 1918: D. Van Nostrand Company. Price, $3 net.

The information given in this book has been drawn largely from the standard works on theory of structures for the principles, formulae and proofs which are essential to a clear understanding of the structural problems in a ship. The theoretical matter is presented in simple language and covers the subject in a general way, in order to give a student or practicing engineer the theoretical ground work for application to special problems.

Shipbuilding and General Marine News

**Contracts for New Ships—Shipyard Improvements—
Engineering Projects—Improved Appliances—Personal Items**

CONTRACTS FOR 61 VESSELS AWARDED BY SHIPPING BOARD

Deadweight Tonnage of Both Steel and Wood Vessels Amounts to 439,800 Tons—Biggest Contract Goes to Pacific Coast Shipbuilder

Contracts for the construction of 61 steel and wooden vessels aggregating 439,800 deadweight tons have been awarded by the Shipping Board during the week ending July 13. Of this tonnage 392,800 tons will consist of steel vessels and the rest of wooden ships.

The largest contract went to the Skinner & Eddy Corporation, Seattle, calling for the construction of 35 steel cargo steamships aggregating 332,800 deadweight tons. The Mobile Shipbuilding Company, Mobile, Ala., received a contract to build 12 steel freighters of a combined tonnage of 60,000, making in all 47 steel vessels provided for in the new contracts.

Contracts for building 14 wooden ships were divided between K. M. Murdock, Jacksonville, Fla., 6 ships of 21,000 tons; the Missouri Valley Bridge & Iron Company, Quantico, Va., 7 ships of 24,500 tons, and the Continental Shipbuilding Corporation, Yonkers, N. Y., 1 vessel of 1,500 tons.

Combustion Engineers Wanted by Oil Division, U. S. Fuel Administration

The Bureau of Oil Conservation, Oil Division, U. S. Fuel Administration, Washington, D. C., is desirous of securing a combustion engineer for each of the following districts, who will act as an inspector, visiting all plants within his district using fuel oil and natural gas: Boston, Providence, New York City, Philadelphia, Pittsburg, Buffalo, Detroit, Chicago, Minneapolis, Tulsa, New Orleans and San Francisco.

It is desirable to have these men act as volunteers where possible, but the Administration is prepared to pay a reasonable compensation for men who cannot afford to give their services to the Government. Only men who have had experience in fuel oil and natural gas combustion would be of value.

British Ship Repair Plants Under One Control

A recent report on the work done in British repair yards which are now coordinated under Government control discloses the fact that in the period from August 3, 1917, when the Control Board was organized, to April 25, 1918, these yards have repaired and restored to service 5,307 vessels, representing an aggregate gross tonnage of 16,150,000 tons. This gives a weekly average for the period of 414,000 gross tons, but the weekly average for some weeks has risen to over 500,000 gross tons, and is steadily increasing.

As much as 2,120,301 gross tons of shipping have been in hand during one week, of which during the week more than half a million tons were restored to service. The amount restored in one week has reached the figure of 598,000 gross tons. Five ships, each of over 20,000 tons, have left the yards ready for service in a single week.

LABOR DAY TO BE ANOTHER RECORD LAUNCHING DAY

American Labor Proposes to Eclipse Fourth of July Launching Records

American labor has proposed to the Shipping Board that Labor Day this year shall be made a second Fourth of July in the launching of a record number of ships to help defeat Germany. Chairman Hurley has referred the proposal to Samuel Gompers, president of American Federation of Labor, who will take up the question with unions on the Pacific Coast, where the suggestion originated, with a view to making the celebration national if it meets general approval.

Pacific Yard Trying to Beat Tuckahoe Record

The Union Iron Works, Alameda, Cal., has started the construction of a 12,000-ton steel freighter with the intention of completing the vessel in 28 days. This is in response to a challenge of the New York Shipbuilding Corporation, Camden, N. J., which launched the 5,000-ton steel freighter *Tuckahoe* 27 days after laying the keel and completing the vessel in 37 days.

Homes to Be Provided for Shipyard Workers on Staten Island

The Housing Department of the Shipping Board has recently decided to erect a large number of houses for shipyard workers on Staten Island. Houses for the accommodation of 30,000 persons have so far been agreed upon.

The five large shipyards on Staten Island, employing about 30,000 workmen, have been seriously handicapped through lack of housing facilities for the workmen's families. Through the efforts of the Merchants' Association of New York the Government has now agreed to provide these necessary facilities and the sites have been decided upon.

THIRTY STEEL CARGO SHIPS TO BE BUILT IN JAPAN FOR SHIPPING BOARD

Japanese Shipbuilders Now Have Contracts for 380,000 Tons of American Shipping—United States Will Supply Steel

Following the conclusion of an arrangement with the Kiangnan Dock & Engine Company, of Shanghai, whereby that company is to build 120,000 tons of steel steamships for the United States Shipping Board, it has been announced that contracts for thirty additional steel cargo steamships had been awarded to Japanese shipyards.

Where the Ships Will Be Built

The yards which have been awarded the contracts and the number of ships which they are to build is as follows:

One cargo ship, Asahi, Osaka, Japan.

One cargo ship, Fujinigata, Osaka, Japan.

Two cargo ships, Harima Company, Aici, Japan.

Two cargo vessels, Ishikawajima, Tokio, Japan.

Five cargo ships, Kawasaki, Kobe, Japan.

One cargo ship, Ritta, Osaka, Japan.

Three cargo vessels, Yokohama, Japan.

Two cargo vessels, Asano, Tsurumi, Japan.

Three cargo vessels, Uraga, Japan.

Two cargo vessels, Mitsue Bussan, Uno, Okayama, Japan.

Two cargo vessels, Mitsubishi, Nagasaki, Japan.

Two cargo vessels, Uchida, Kawasaki, Japan.

Four cargo vessels, Osaka, Japan.

150,000 Tons Already Chartered

The Shipping Board had already chartered 150,000 tons of shipping from Japan and purchased another 127,000 tons. Some of the ships will be equipped with guns and gun crews and put immediately into the overseas service to carry men and supplies to France. Others will be used in the coastwise and South American trades.

Total contracts now let to Japanese shipbuilders provide for 380,000 tons of shipping, including 50 cargo carriers. These will cost approximately $78,000,000, of which about $20,000,000 has been expended. The estimate of the Shipping Board, which was submitted to the Appropriations Committee of the House, asked for an additional $55,000,000 for this purpose. The Shipping Board had also permitted Japan to obtain 100,000 tons of steel plates, and will now provide 35,000 tons for this new construction.

CHINA TO BUILD SHIPS FOR THE UNITED STATES

Contract Let by Shipping Board for Four Cargo Vessels of 10,000 Tons Each

Contracts for the construction of four cargo vessels of 10,000 tons each, and options for the building of 80,000 tons additional, were awarded by the Shipping Board on July 13 to the Chinese Government yard at Shanghai. The vessels will be built by the Kiangnan Dock & Engine Works, Shanghai, whose manager, Mr. R. S. Mauchan, negotiated the contracts as the representative of the Chinese Minister of the Navy, whose department has control of the yard.

Ship Fabricating Steel Plant to Be Built at Birmingham

H. L. Brittain, president of the Mobile Shipbuilding Company, Jacksonville Dry Docks & Repair Company, vice-president of the Terry Shipbuilding Company at Savannah, and several other corporations in New Jersey, closed a deal at Birmingham, Ala., for a 53-acre tract of land upon which will be constructed a mammoth fabricating steel plant, representing an immediate investment of $1,000,000, employing 200 men, to be financed by the Emergency Fleet Corporation for the manufacture of steel plates, shapes and other structural material for ship construction.

Cape Cod Canal Under Government Control

To protect New England's coal supply from Southern ports from the submarine menace the control of the Cape Cod Canal has been taken over by the Government. The canal will be operated by the Railroad Administration.

Turbine Production Controlled by Government

To insure the proper supply of turbines for ships for the navy and the Emergency Fleet Corporation, the Government has assumed control of the turbine engine industry of the country. Manufacturers of turbines under 700 horsepower do not come under Government supervision.

Third Ship Launched by Universal Shipbuilding Company

With the launching of the steamship *Banicaa,* a Ferris type wooden steamer of 3,500 tons deadweight, on July 16, the Universal Shipbuilding Company, Houston, Tex., has so far put into the water three vessels. The fourth was scheduled for launching three weeks later.

E. P. Morse, Jr., Heads New Dry Dock Corporation

E. P. Morse, Jr., formerly associated with his father in the Morse Dry Dock Company, Brooklyn, N. Y., is now head of the National Dry Dock Company, Richmond, Staten Island, N. Y., recently organized to take over some of the repair plants on Staten Island. The company is now bidding for the property of the McAllister Dry Dock & Repair Company, West Brighton, N. Y., which is equipped with a 4,000-ton floating dry dock and three smaller docks.

Associated with Mr. Morse are C. Palmer, A. McManus and E. J. Donegan. Mr. Morse was the designer of the 30,000-ton dry dock at the Morse plant in Brooklyn.

SHIPPING BOARD FINDINGS AFFECTING MARINE ENGINEERS AND AMERICAN STEAMSHIP ASSOCIATION

Rules Agreed Upon at National Marine Conference—Wages, Hours of Labor, Holidays, Subsistence and Other Questions Decided

At the national marine conference held in May, 1918, the following rules, Nos. 3, 4, 7, 10, 12, 13, 14 and 15 had not been agreed upon between the Marine Engineers' Beneficial Association and the American Steamship Association, and accordingly were submitted to the Shipping Board for adjudication. The Shipping Board has made the following findings with respect to these rules:

Rule 3. If, while the vessel is in port, an engineer is required to stay aboard at night after having worked all day and not required to do work not necessary for the safety of the vessel, he shall be paid at the rate of time and a half for the full period of night duty or be given a day off with half pay and six hours' pay at the rate of time and a half. If the engineer is required during such night duty to do any work that is not necessary for the safety of the vessel, he shall be paid at the rate of double time for all such hours' work. If an engineer is required to stay aboard on a Sunday or legal holiday he shall be paid time and a half. For the purpose of these rules the time and a half rate shall be 70 cents, and the double time rate shall be $1. Overtime, when generally referred to, shall be figured at the time and a half rate.

Rule 4. All work done off watch at sea, except that which is necessary for the immediate safety of the vessel, shall be paid for as overtime.

Rule 7. Holidays shall be Sundays, New Year's Day, Fourth of July, Labor Day, Thanksgiving Day and Christmas Day, and shall be observed at all ports.

Rule 10. (It is the opinion of the Shipping Board that during the period of the war the demands of the M. E. B. A., as expressed in Rule 10, should be waived, and that no such rule should be adopted at this time).

Rule 12. Chief engineers shall receive for subsistence allowance $2 per day, assistant engineers $1.50 per day.

Rule 13. Ship's articles shall contain a provision providing for the payment of wages and suitable transportation back to the point where articles were originally signed in the event that the vessel is sold, unless the officer is given a reasonable opportunity immediately to re-ship for the home port at an equal salary.

Rule 14. In the interest of uninterrupted and rapid operation of vessels during the war all grievances of cases arising from the non-observance of these rules should at once be reported to the Shipping Board for adjustment, this provision to hold only during the period of the war. A violation of these rules on the part of a member of this association shall be considered conduct unbecoming a member, and such a member shall be subject to the penalty prescribed by the by-laws.

Rule 15. (It is the opinion of the Shipping Board that the claims advanced in Rule 15 should be waived during the period of the war).

Not Acted Upon by Shipping Board

The following rules of the Marine Engineers' Beneficial Association, Nos. 1, 2, 5, 6, 8, 9 and 11, had been agreed upon between this association and the American Steamship Association and were not submitted to the Shipping Board for adjudication. Accordingly the Shipping Board has taken no action with regard to these rules:

Rule 1. Watch and watch to be maintained on sailing day and at all outside ports at all times. No engineer shall be required or permitted to take charge of a watch upon leaving or immediately after leaving port unless he shall have had at least six hours' off duty within the twelve hours immdiately preceding the time of sailing.

Rule 2. A working day at outside ports, or any port where watches are broken, shall be from 8 A. M. to 5 P. M., during which time one hour shall be allowed for dinner. All work performed in excess of this time after 5 P. M. and up to 8 A. M. shall be considered as overtime. If an engineer is required to perform night service, eight hours of such service shall constitute a day's work. (Provided, however, where there shall be a mutual agreement between the engineers on board relative to their watch this rule shall not apply).

Rule 5. If it is necessary to move a vessel in inside ports between 5 P. M. and 8 A. M., or on Sunday or legal holiday when a vessel arrives from a voyage and anchors, or makes fast to a wharf, to wait for a suitable tide or berth or discharge passengers, or baggage, or receive fuel, the engineers shall continue their regular watches at the option of the chief engineer.

Rule 6. In any case where an assistant engineer is required to perform service in excess of eight hours per day, all such work shall be paid for as overtime at the rate of 70 cents per hour. Chief engineers shall not be entitled to pay for overtime. Overtime shall not be payable unless such service shall have been performed upon the written order of the chief engineer, master, owner or agent of the vessel.

Rule 8. No engineer shall be laid off over a Sunday or holiday, and a full complement of engineers shall be employed at all times while the vessel is working cargo or in commission.

Rule 9. The chief engineer shall be notified at the time of the arrival, or as soon as possible thereafter, of any anticipated detention of the vessel.

Rule 11. Chief engineers shall be employed by the owners, superintending engineers or agent; assistant engineers to be selected by the superintending engineer, owner or agent, after consultation with the chief engineer.

Shipbuilding Contracts

The United States Shipping Board has let contracts which have been distributed among the shipyards of the Atlantic and Pacific coasts for 92 large troopships, which are to be completed before the end of 1919.

The Todd Shipbuilding Company, 15 Whitehall street, New York, has received an order from the United States Shipping Board to build 12 steel steamships, each having a carrying capacity of 7,500 tons. They will be built at the yard of the Dry Dock & Construction Company, Tacoma, Wash., a subsidiary company. It is reported that each of these vessels will have a deadweight tonnage of 10,000.

Order for Pacific Coast

The Columbia River Shipbuilding Company, Portland, Ore., A. F. Smith, president, has received contracts to build fourteen 8,800-ton steel steamships for the United States Shipping Board.

The Portland Shipbuilding Company, South Portland, Me., Edmund R. Norton, president, is building six trawlers for the Bay State Fisheries Company, Boston, Mass.

Five Revenue Cutters Ordered

The Port Huron Foundation Company, Port Huron, Mich., is reported to have received a contract from the United States Coast Guard Service to build five 280-foot revenue cutters.

It is reported that two of the 40,000-ton battleships recently authorized by Congress will be constructed by the Brooklyn Navy Yard.

It is reported that the Mobile Shipbuilding Company, Mobile, Ala., has received a contract from the United States Shipping Board to build twelve 5,000-ton steel steamships.

The Cornwall Construction Company, Tampa, Fla., will build four 3,000-ton wooden freight steamships.

The Pacific Coast Shipbuilding Company, San Francisco, Cal., is reported to have received a contract to build ten 9,400-ton ships for the United States Shipping Board.

Contracts for Japan

The United States Shipping Board, Washington, D. C., has closed contracts with Japanese shipyards for thirty steel steamships to cost about $78,000,000.

The United States Shipping Board is also making arrangements to build twelve or more steel steamships in China. Contracts have already been placed in that country for four ships of 10,000 tons each.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has received a contract to build two more of the large transports to be built for the War Department, and also contracts to build eight oil tankers and several more freight steamships.

The Mobile Shipbuilding Company, Mobile, Ala., W. L. Kelly, president, has received a contract from the Shipping Board to build twelve 5,000-ton steel steamships.

The Sehrs Shipyard, Irondale, Wash., has received a contract to build two wooden steamships for the French Government, and a railway ferry barge 160 feet long.

The Union Bridge & Construction Company, Morgan City, La., has a contract from the Shipping Board to build three barges.

The Standard Shipbuilding Corporation, 44 Whitehall street, New York, José Marimon, president, has leased the Birch Point Shipyard at Wiscasset, Me., where it has a contract to build six ships.

The Machias Ship Construction Company, Bangor, Me., is building two 1,000-ton wooden ships.

The Puget Sound Bridge & Dredging Company, Seattle, Wash., has received a contract from the United States Shipping Board to build a 5,000-ton wooden ship.

Concrete Ship *Faith* at Sea in Storm With Rail Awash

Increased Cost of Ships

Reports show that a vessel recently contracted for, which would have cost before the war $75 to $80 a ton, was built at a cost of $230 to $240 a ton.

Another case was cited of two sister ships built in England, one of which was contracted for in the early stages of the war and completed in February, 1917, and the other completed in May, 1918. The increased cost on the hull was 58 percent for the 1918 steamer as compared with the 1917 vessel, while there was an increase of 206 percent on the machinery.

Sea Breaking Over Deck of Concrete Ship *Faith*

Concrete Ship "Faith" Weathers Heavy Gales Without Mishap

On June 7 the 5,000-ton concrete ship *Faith*, completed at Vancouver her first ocean voyage, which was started from San Francisco on May 22 with 4,300 tons of salt and copper ore. During this voyage the *Faith* encountered very severe storms, some being gales ranging from 40 to 80 miles or more per hour, but she weathered them all successfully, and arrived at her destination without any mishap whatever.

Twenty Troopships to Be Built at Alameda, Cal.

During the week ending July 5 contracts for 20 troopships were awarded to the Bethlehem Shipbuilding Corporation, of Alameda, Cal. During the same period the Shipping Board contracted for the building of three barges, the award going to the Union Bridge & Construction Company, of Morgan City, La.

Henry Penton Appointed General Manager Ninth District

The appointment of Henry Penton as manager of the Ninth District was announced by Vice-President Charles Piez, of the Emergency Fleet Corporation, on July 2. Mr. Penton will be the resident representative of the vice-president's office, and will have supervisory jurisdiction over all phases of ship construction and inspection in his district.

NEW SHIPYARDS AND EXTENSION OF EXISTING YARDS

Additions, Improvements and Orders for New Equipment

The J. H. Price Shipbuilding Corporation has purchased the Standstrom Shipbuilding Company's plant at Seattle, Wash.

The Federal Shipbuilding Company, Kearney, N. J., is said to be planning the construction of a 1,000-foot dry dock.

The Ambursen Construction Company, 51 Broadway, New York, which has received a contract from the United States Shipping Board to build four concrete-steel barges, will build a plant at Little Ferry, N. J.

Government Concrete Shipyard at Mobile

The Emergency Fleet Corporation, Washington, D. C., is reported to have decided to build twelve ways at Mobile, Ala., for the construction of concrete vessels. The Fred T. Ley Company, of Springfield, Mass., and 19 West Forty-fourth street, New York, is stated to have the contract to build this shipyard and also to build eight 7,500-ton concrete ships.

The Atlantic Fish Company, New York, and the Bay State Fisheries Company, Boston, Mass., have organized the Greenpoint Ship Company to acquire the Sterling Shipyard Company, Greenpoint, L. I.

The Hudson Shipbuilding & Repairing Company has been organized, with headquarters at 239 Washington street, Jersey City, N. J.

The United States Shipping Board will erect a shipyard at Somerset, Mass., to be operated by the Crowninshield Shipbuilding Company, South Somerset.

The Traylor Shipbuilding Corporation, Cornwells, Pa., is planning to build a 1,200-foot equipment dock, and contemplates the construction of two 500-foot dry docks.

The Union Shipbuilding Company, Fairfield, Md., a branch of the Riter-Conley Manufacturing Company, Pittsburg, Pa., is planning the construction of two new shipways.

The Crisfield Shipbuilding Company, Crisfield, Md., will enlarge its plant to provide for the building of two steamers and a number of tugboats, contracts for which have been received from the Government.

The Muller Shipbuilding Company has been organized at Los Angeles, Cal., by A. B. Cass, L. Cass, C. G. Lynch, A. M. Leaf and J. E. Shelton.

The Inter-Ocean Barge & Transport Company, Seattle, Wash., G. N. Linemire, president, will build a shipyard for the construction of concrete vessels.

Mammoth Plant for Submarines

The Lake Torpedo Boat Company, Bridgeport, Conn., is understood to have made plans for an extension which will make it the largest plant in the world devoted exclusively to the construction of submarines.

The California Shipbuilding Corporation, Los Angeles, Cal., will build a shipyard in Los Angeles harbor.

Anthony O. Boyle, 1 Broadway, New York, has purchased waterfront property at Greenpoint on which he is planning to build a shipyard.

The American Concrete Pipe & Shipbuilding Company, Seattle, Wash., which is planning to build a concrete shipyard at Lake Washington, states that it will build ten ways which will permit the construction of 10,000-ton concrete ships. W. F. Hallowell is secretary.

The Delta Shipbuilding Company has been organized in New Orleans, La., by Richard B. Stanford, Charles A. Koch and others.

The merger of the Seattle Construction & Dry Dock Company with the Skinner & Eddy Corporation, Seattle, Wash., will result in extensive enlargements and improvements.

The Concrete Ship & Barge Company has been organized in Newark, N. J., by C. M. Sexton, 191 South Clinton street, Jersey City, N. J., and others.

The Standard Shipbuilding Company, 44 Whitehall street, New York, Jose Marimon, president, will make additions to its plant at Shooters Island, Staten Island.

Ford Plant at Kearney, N. J.

Plans have been prepared by the Ford Motor Company, Detroit, Mich., for the construction of a plant at the Passaic River at Kearney, N. J., for the manufacture of submarine chasers.

It is reported that Charles M. Schwab, Director General of the Emergency Fleet Corporation, is planning the construction of a large shipyard on the Philadelphia waterfront.

The West Coast Shipbuilding Company has been organized by C. C. Spicer and A. G. Keating, H. W. Hellman building, Los Angeles, Cal.

It is reported that the Bethlehem Steel Corporation, Bethlehem, Pa., has completed plans for the construction of another shipyard for the Government of the same general type and capacity as that now being constructed at Alameda, Cal. It is said that the new yard, together with its equipment, will cost in the neighborhood of $25,000,000.

The National Dry Dock & Repair Company has been incorporated by C. Palmer and J. A. McManus, 27 William street, New York.

The United States Shipping Board has completed negotiations with the city of San Diego, Cal., for a lease of waterfront for a new shipyard. It is understood that the yard will be constructed by the Schofield Engineering Company, San Francisco.

The United States Shipping Board is planning the construction of a shipyard and dry docks at Norfolk, Va.

The Muller Shipbuilding Company has recently been organized in Los Angeles, Cal., and is said to have completed plans for a shipyard at San Pedro. Luis and A. B. Cass, Los Angeles, are among those said to be interested.

The Brunswick Marine Construction Corporation, Brunswick, Ga., W. U. Taylor, president, is reported to be planning to enlarge its shipyard and equip it for the construction of steel vessels.

The Delta Shipbuilding Company, R. B. Sanford, president, Metropolitan Bank building, New Orleans, La., has acquired a site and will equip the plant to build concrete ships.

O. A. Bloxom, Battery Park, Va., has organized the Bloxom Brothers Shipbuilding Company, for the purpose of building wooden schooners, barges and tugs.

The Terry Shipbuilding Corporation, 70 East Forty-fifth street, New York, is reported to be planning the erection of a shipyard at Hunters Point avenue and Orton street, Long Island City, N. Y.

The Boston & Penobscot Shipbuilding Company has been organized. Among the incorporators are G. H. Lucey, Swampscott, Mass., and W. R. Burhoe, Reading, Mass.

The Fabricated Ship Corporation has been organized in Richmond, Va. A. L. Langley is president, C. P. Royster, vice-president, and R. G. Dashiell, secretary.

The Ogdensburg Shipbuilding Corporation has been incorporated by C. R. Allison, H. L. Andrews and A. M. Skivens, 111 Broadway, New York.

The Inter-Ocean Barge & Transport Company, Seattle, Wash., has completed plans for building a concrete ship plant. The company is reported to have already received a contract to build two concrete ships.

James W. Black and others will, according to report, build a shipyard at Plaquemine, La., with eight ways.

It is reported that A. E. Welsh, of Enfield, Ill., will organize a company to build a shipyard at Tarpon Springs, Fla.

The Slidell Dry Dock & Shipbuilding Corporation has been organized at Slidell, La. Andrew Canulette is manager.

The Transatlantic Shipyards Corporation, 95 Liberty street, New York, has acquired the shipbuilding works at Tottenville, Staten Island, formerly operated by J. S. Ellis & Son.

Rate of Accidents in Shipyards

Complete refutation of the insidious stories recently circulated by German propagandists, to the effect that more men are being killed and injured in our shipyards than are being killed and injured in the trenches, was recently made in a statement from the Industrial Relations Division of the Shipping Board. According to this statement, in spite of considerable additions to most yards and the confusion attendant upon increasing capacity in practically all yards, the rate of accidents in connection with shipbuilding to-day is not as high as that which obtains in the manufacture of steel, and is practically the same as in the general industrial rate. The Department of Labor Statistics show that the accident rate in shipyards from 1912 to 1916 is approximately 21.8 for every thousand men. These figures cover a period previous to the enlarged shipbuilding activities in this country.

At Hog Island during May this year the average force of men employed was 20,897. The number of accidents which caused loss of time was 107, which gives a rate of six for every thousand men, as compared to the rate of 21.8 for the period from 1912 to 1916. This decreasing rate of accidents is due to the very effective work of the Department of Safety Engineering organized by the Emergency Fleet Corporation and also the Department of Health and Sanitation. To-day every district in the country has its competent safety engineer, who is co-operating with the shipyards to keep down the number of accidents and prevent the hazards that are common to any structural industry.

New Compressed Air-Operated Tool for Driving Spikes, Drift Bolts and Pins

The timber in wooden ships, docks and cribs is usually secured with spikes or drift pins driven in place by hand. Where such work is done, compressed air is ordinarily available, for in wood construction, as in steel, a variety of air-operated tools does better work and faster work than can be done by manual labor. The new driver shown in the illustration is operated by compressed air, and will drive in a day, or a shift, more spikes, drift bolts or pins than can be driven by hand and with less physical effort.

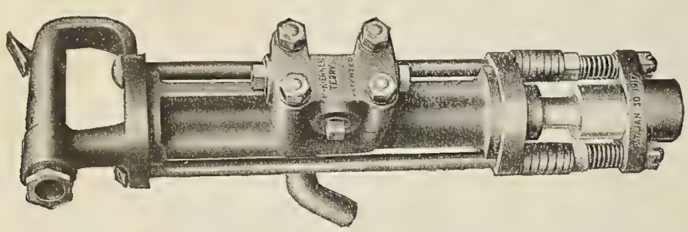
This driver strikes a powerful blow, and will drive drift bolts or pins of the largest size. Owing to its lightness it is easily handled by the operator when driving either in a horizontal or a vertical direction.

If a hand-driven bolt is struck a foul blow it will bend, and if not properly straightened is very difficult to drive. The machine-driven spike or bolt does not bend. The compressed air-operated driver delivers a succession of rapid and powerful blows on the bolt head, forcing it forward quickly and in true alignment with the bolt hole until brought up flush to the surface of the timber.

The spike or bolt is first given two or three blows with a hand hammer to start it into the hole bored to receive it, and is then sent home with the driver.

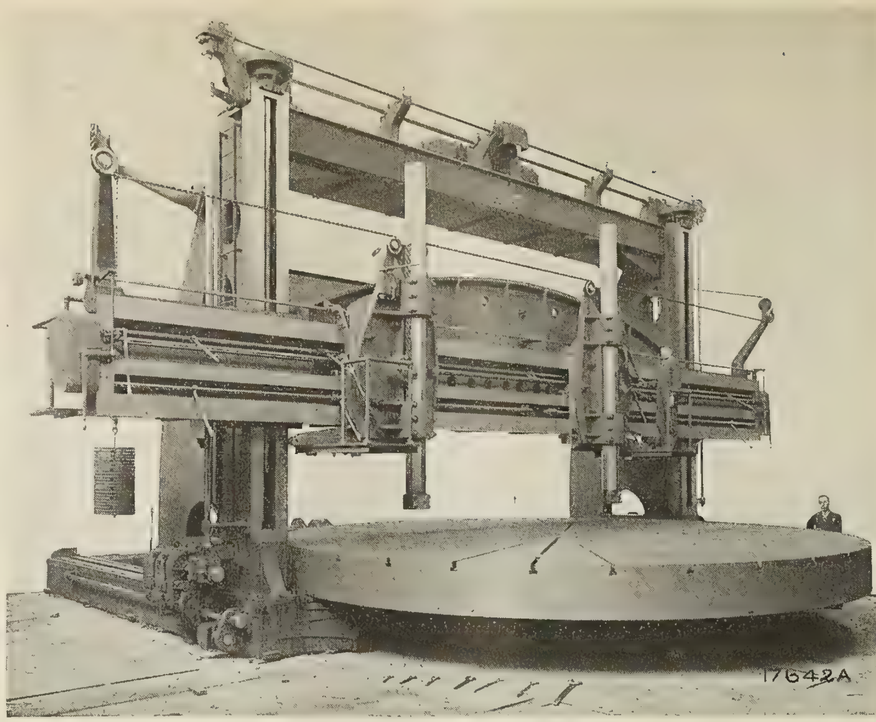
In a shipyard building wooden vessels one of these drivers drove home inch and a quarter by 28-inch spikes at an average speed of 9 seconds each, which indicates clearly the economy as compared with hand driving.

The tool is designed along the lines of a hammer drill, and is controlled by a trigger valve in the handle, which is moved by the thumb of the operator. The top head, cylinder and front head are held firmly together by side rods, the latter extending below the front head to support a spike-holding socket, which is held away from the front head by spiral springs. By bearing down on the driver handle, the spike-holding socket moves back and over the driving spud, or anvil block, so that the spike, bolt or pin may be driven flush to the surface of the timber. During this operation the position of the driving spud or anvil block in the cylinder is unchanged, so that the full power of the piston's blow on the drift bolt is as great on the last stroke as on the first.



Pneumatic Tool for Driving Drift Bolts, Spikes and Pins

This compressed air-operated driver is 23½ inches long over all, weighs 46 pounds, is of steel throughout, and all wearing parts and surfaces are carefully hardened and ground. It is manufactured by McKiernan-Terry Drill Company, 21 Park Row, New York.



Huge Boring and Turning Mill Built by Niles-Bement-Pond Company for the Government

28- to 42-Foot Extension Boring and Turning Mill Built for Arsenal Work

A 28- to 42-foot extension boring and turning mill was recently built by the Niles-Bement-Pond Company, New York, for arsenal work. The machine swings 28 feet 2 inches with the housings forward, and 42 feet 4 inches with the housings back. The maximum height under the tool holders is 10 feet; the bar travel 84 inches.

The table is driven by a 60-horsepower motor through a double pinion drive. A 25-horsepower motor is used for elevating the cross-rail, and a 15-horsepower motor for fast traversing the bars and saddles. A separate 15-horsepower motor is used for traversing the housings. Push button control is provided for all motors.

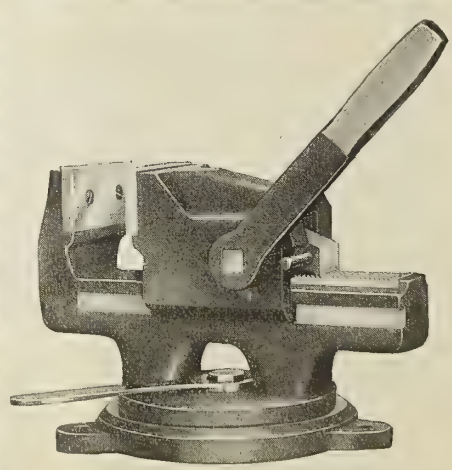
The cross-rail has two heads, with octagon bars 10 inches across the flats. The cross-rail is 48 inches in width and 54 inches in depth from front to back.

The table is designed to carry safely a load of 300,000 pounds in addition to its own weight. The table is driven by two forged steel pinions, one located on each side of the table. The heads on the cross-rail are provided with platforms for the operator. The adjustment of feeds and rapid traverse for bars and saddles is controlled from the platforms. The main driving motor is also controlled from these platforms as well as from stations at each side of the machine.

Winans' New Idea Vise

The Barnett Foundry & Machine Company, Irvington, N. J., has just brought out a machinists' bench vise under the name of "Winans' New Idea Vise" that embodies many novel features. Reference to the illustration will point out its general characteristics. It will be seen that the old-fashioned screw and lever has been replaced by a pawl and rack. This is actuated by a handle on an eccentric shaft, which will exert a pressure many times that possible with a screw.

The adjustments from 0 to maximum are made instantly with one sliding movement. The pawl eccentric and sliding jaw form a toggle joint, bringing the greatest pressure to bear on the top part of the jaws, causing the work to be clamped tightest at the working part. The moving member of the vise slides away from the operator, and there is no



Bench Vise of Novel Design

handle between operator and the vise. The gripping plates are hardened and ground, and the rack and pawl are also hardened steel.

A feature of especial importance is that the whole vise may be removed from its swivel base and taken to surface plate, drill press or milling machine for continuous operations, since the base of the vise is accurately machined to right angles with the jaws.

These vises are made in standard sizes of jaws from 3 inches to 8½ inches, and openings of 3½ inches to 12 inches.

Multiwhirl Cooler

In these days of large marine turbines it is imperative that the lubricating oil supplied to the bearings is of correct temperature to maintain an oil film of proper viscosity between the bearing surfaces. The most efficient means of accomplishing this result is by cooling the lubricating oil to the proper temperature. This also permits the continued use of a given quantity of oil.

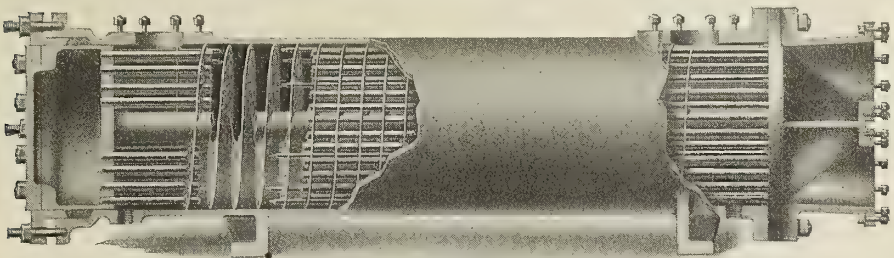


Fig. 1.—Sectional View Multiwhirl Cooler

The subject of oil cooling is quite complex, in that the variables encountered, which determine the transfer surface for any given form of cooler, depend not only on the character of the oil, the inlet and outlet temperatures of the oil, the inlet temperature of the water and the quantity ratio of oil and water, but also materially on the temperature level or the portion of the temperature viscosity curve through which the cooling is to take place. The viscosity of the oil plays an important part, inasmuch as the necessary transfer surface varies with it.

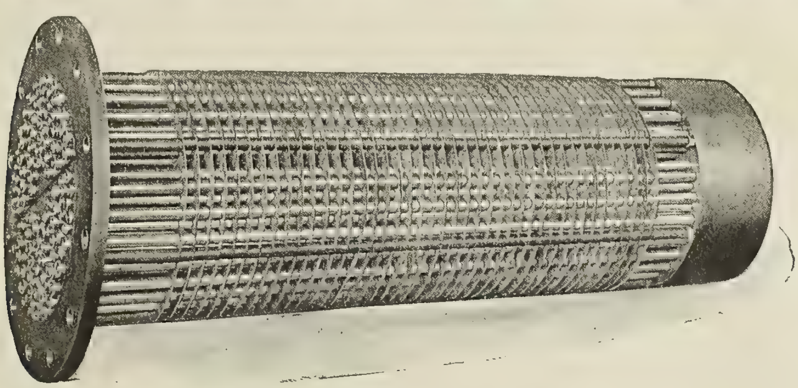


Fig. 2.—Tube Bundle and Baffle

The engineering and designing staffs of The Griscom-Russell Company, New York, after years of experience with many forms of heat transfer apparatus, developed the multiwhirl cooler shown in the accompanying illustrations. This period of development was followed by a series of tests to determine the proper ratings, pressure losses, etc., for various grades of oil. The results secured were far beyond expectations, the heat transfer being greater than has been secured in any previous form of commercial oil cooler and the pressure losses correspondingly lower.

Fig. 1 shows a sectional view of the multiwhirl cooler. The shell is of close-grain cast iron. The cooling surface consists of small diameter smooth bore, straight copper or brass tubes, expanded into tube plates without the use of any glands or packing. One tube sheet is bolted solidly to the shell and the other is bolted to a floating head, which permits of expansion and contraction of the tubes without strain on joints. The entire tube bundle and baffle are removable from the shell for inspection without breaking any of the oil connections. This also facilitates cleaning should same become necessary. Fig. 2 shows the tube bundle and baffle withdrawn from the shell.

The baffle is made of sheet iron perforated to permit the insertion of cooling tubes. Spacer rods are located near the circumference of the baffle to insure rigidity and maintain an equal cross section of flow for the oil throughout its entire path. By the use of this form of baffle a maximum length of oil path is secured for a given amount of cooling surface and length of shell. The oil pressure loss is a minimum, because the baffle directs the flow of oil without appreciably retarding its progress. In operation the lubricating oil is constantly circulated through the shell by pump pressure, and is brought into intimate contact with the cooling surface by means of the helical baffle.

New Pressure Governor for Gas and Liquid Systems

In many power installations, where air, other gases or liquids must be maintained under pressure, the demand for an automatic method of doing this has arisen. As a result, the General Electric Company, Schenectady, N. Y., has developed a new pressure governor to control standard self-starters for motor-operated pumps and compressors. The governor maintains a pressure between predetermined limits on any gas or liquid systems that will not corrode the Bourdon tube.

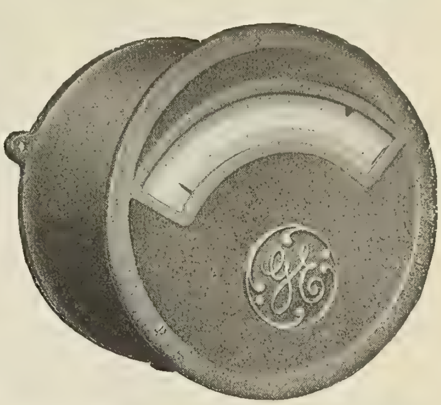


Fig. 1.—Contact Making Pressure Governor

This governor is called the CR 2,922, and can be used on any standard A. C.

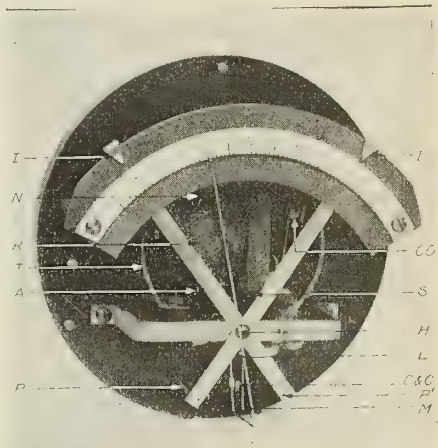


Fig. 2.—Internal Mechanism of Pressure Governor

of 80, 100, 160, 300, or 500 pounds, and operates within settings of from 3 to 12 pounds between high and low pressures. Governors for higher pressures can be supplied if desired.

The governor consists of a Bourdon tube, an indicating needle, a graduated pressure scale, adjustable high and low pressure stops to determine the desired pressure range, and a relay which actuates the contacts in the control circuit of the self-starter, all enclosed within a dust-proof case, easily opened for inspection.

Action of the governor is dependent on the Bourdon tube, which should be connected to an independent discharge pipe from the pressure tank. The free end of the tube *T* (Fig. 2) is mechanically connected to the indicator needle *N*,

moving it over the scale as changes of pressure affect the tube.

After the settings for the pressure range have been made, the governor will automatically maintain pressure within those limits. The operation of the pressure governor is as follows:

Assuming that the pressure is at the low value, as indicated by the left-hand indicator *I*, the contact *C* on the needle *N* completes the circuit through the contact *C′* on the movable arm *M*, which at low pressure point rests against the stop *P*. When this contact is made, the circuit is completed through the relay coil *R*, causing the armature *A* to close. Attached to this is the contact *CO*, which upon closing completes the control circuit to the self-starter, causing the motor to start.

The armature is also attached to the spring *S*, which holds the contact *C* firmly against *C′* until contact is broken at *P*.

As the pressure increases the needle pointer moves to the right, but its lower part, to which the contact *C* is attached, moves to the left, and is followed by the movable arm *M*. When the high pressure point is reached the movable arm is prevented from traveling further by stop *P*, and the needle continues its course, breaking the circuit by separating contacts *C* and *C′*. The instant the circuit is broken the relay *R* is deenergized, its armature falls, releasing the tension of the spring *S*, and because the movable arm *M* is counterweighted it returns to the stop post *P*.

When the pressure is decreased to the minimum value, the contact *C* again completes the relay coil circuit by engaging contact *C′*, and the cycle of operation is repeated.

The case is tapped and drilled at the bottom for the pressure pipe and electrical conduit connections.

No Immediate Shortage of Engineer Officers

Agents of the United States Shipping Board Sea Service Bureau from Atlantic, Gulf, Pacific and Great Lakes ports, in conference June 26, 27 and 28 at national headquarters of the Shipping Board Recruiting Service at Boston, saw no probable shortage of engineer officers any time in the next few months. A country-wide canvass showed that 90 percent of marine engineers now employed ashore in responsible positions are willing and anxious to return to the sea the moment the Government needs them. Supplementing the large number of marine engineers who are being trained in the Shipping Board free schools, the licensed officers now in shore positions form a reserve that should result in no ships being kept from moving because of a lack of chief or assistant engineers.

The conference resulted in numerous problems pertaining to the better manning of the merchant marine being solved.

Thursday the agents went out into Massachusetts Bay on the training ship *Calvin Austin* to see merchant marine apprentices in actual training under the Shipping Board. That evening they tendered a dinner at the Harvard Club, where there were addresses by Henry Howard, director of the Shipping Board Recruiting Service; Edward F. Flynn, assistant to the director; Capt. Eugene E. O'Donnell, of Boston, and others.

Those attending the conference included Edward C. Hovey, Jr., Cleveland Bigelow and Harrington Pike, of Boston; Russell Patterson, New York; William G. Rice and James Thompson, Philadelphia; Capt. John W. Inglesby, Newport News; J. W. Lindau, Baltimore; Frank W. Spencer, Savannah; Philip A. Shore, Tampa; Capt. Ernest E. B. Drake, New Orleans; Capt. John Leale, San Francisco; E. J. Griffith, Seattle; Capt. Irving L. Evans, Cleveland, and James L. Ferguson, Charleston.

New Canadian Yard to Build Ships for France

A new shipbuilding syndicate, capitalized at $5,000,000, has been organized to operate a large shipyard on the St. Lawrence River opposite Quebec City. This syndicate comprises the Victoria Shipbuilding Company, of Sarnia; the Dominion Shipbuilding Company, of Collinwood; Dussault & Hutchison, of Levis, and a number of old French capital interests. This firm will build steel vessels for the French Government.

PERSONAL

LUTHER D. LOVEKIN, formerly chief engineer of the New York Shipbuilding Corporation, Camden, N. J., has been elected a vice-president of the American International Shipbuilding Corporation, Hog Island, Philadelphia. Since the construction of the Hog Island yard was begun, Mr. Lovekin has served as consulting engineer of the American International Shipbuilding Corporation.

J. H. ROSSETER, vice-president and general manager of the Pacific Mail Steamship Company, San Francisco, Cal., has been appointed director of the Department of Operations, United States Shipping Board Emergency Fleet Corporation, vice Edward F. Carry, who has resigned to become chairman of the Port and Harbor Commission.

REAR ADMIRAL FRANCIS T. BOWLES, assistant general manager of the United States Shipping Board Emergency Fleet Corporation, formerly in charge for the Government of the shipyards on Hog Island and Bristol, Pa., has been given complete charge of all the shipyards included in the tenth shipbuilding district of the Emergency Fleet Corporation, which includes all the yards on the Delaware River.

E. B. SCHOCK, naval architect, Seattle, Wash., formerly of New York City, has accepted the position of naval architect with the Anderson Shipbuilding Company, Houghton, Wash.

E. T. SEDERHOLM, of Pomona, Cal., has been appointed mechanical engineer to the Cleveland district of the Emergency Fleet Corporation, with headquarters in the Perry-Payne building, Cleveland, Ohio.

J. HARRY MULL, vice-president and general manager of William Cramp & Sons Ship & Engine Building Company, Philadelphia, has been elected president of the company, succeeding Henry W. Hand, resigned. Mr. Mull is one of the veterans of the Cramp Company, having been associated with it since 1880. He has held successively the offices of general superintendent, manager of the marine department, and more recently vice-president and general manager.

CARL W. HAEFNER, formerly of the Turner Construction Company, has become associated with Fay, Spofford & Thorndike, consulting engineers, Boston, in the construction of the new Government shipping terminal at South Boston.

CHARLES H. CROWELL, district supervisor of the Emergency Fleet Corporation, Houston, Tex., has been appointed manager of the Stonington (Conn.) Shipbuilding Company.

ALEX MAITLAND has been appointed district supervisor of the Emergency Fleet Corporation, Houston, Tex., vice Charles H. Crowell, resigned.

EADS JOHNSON, formerly in charge of the New York City office of the Emergency Fleet Corporation, has incorporated a firm in New York under the name of Marine Architects & Engineers, capitalized at $75,000. The other incorporators are A. Collins and J. T. McGovern.

ROBERT S. MOORE, president of the Moore Shipbuilding Company, Oakland, Cal., has retired from active service, becoming chairman of the board of directors. Mr. Moore is succeeded by George A. Armes.

JOHN PUDZ has resigned as district auditor of the Emergency Fleet Corporation at Seattle, Wash., to become assistant general manager and comptroller of J. S. Duthie & Company, of Seattle.

SIR THOMAS L. DEVITT, Bart., was reelected chairman of Lloyd's Register of Shipping at its recent annual meeting, and Sir Edward E. Cooper was reelected deputy chairman. Sir Thomas J. Storey was also elected chairman of the classification committee.

W. H. CALLAN, general manager of plants, and W. P. Pressinger, manager of sales, have been elected vice-presidents of the Chicago Pneumatic Tool Company, Chicago, Ill.

P. B. FINDLEY, technical editor, Department of Publicity, Westinghouse Electric & Manufacturing Company, has resigned to enter the training school at the University of Pittsburg for a special counsel in radio work with the United States Signal Corps.

THEODORE BRENT, traffic expert with the Fuel Administration, and former member of the Shipping Board, has been appointed traffic manager of the Mississippi River Barge Line.

H. A. SCHULTZ has been appointed executive head of the Safety Engineering Section of the Industrial Relations Group of the Emergency Fleet Corporation.

R. W. LEATHERBEE has been appointed general supervisor of the District Representatives of the Industrial Relations Group of the Emergency Fleet Corporation.

OBITUARY

CHARLES MALLORY, retired, formerly vice-president of the Mallory Steamship Company, New York, and a son of the founder of the line, died at his home in Port Chester, N. Y., on July 8, aged 74.

ROBERT S. ARMSTRONG, of New York, fabricating engineer for the Carolina Shipbuilding Corporation, died suddenly of apoplexy in Wilmington, N. C., on July 16.

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American Shipbuilders Making Good

WITH the launching of 123 merchant vessels of 631,944 deadweight tons in July—more than have been launched from American shipyards in any previous twelve months—American shipbuilders are making good. In response to a message from the chairman of the Shipping Board giving details of some of the recent accomplishments in American yards, General Pershing cabled, "The news thrills every American in France. Well done!"

In July, American shipyards completed 41 merchant vessels of 235,025 deadweight tons. From August, 1917, when the present Shipping Board began operations, up to August 1 of this year, there has been completed and placed in service 247 ships aggregating 1,571,856 deadweight tons. Almost half of this tonnage was delivered during the last three months, the actual amount being 775,545 tons. Up to August 24, when the last figures were available, 535 merchant vessels of 2,923,973 deadweight tons had been launched from American shipyards as a part of the Government shipbuilding programme, and 281 vessels of 1,725,731 tons has been delivered.

An Epoch-Making Launching

IN ordinary times the launching of a 7,500-ton steel steamship would be an event too commonplace to call for special comment, but to appreciate the real significance of the launching of the first ship of this size at Hog Island last month it is well to ponder the comments of such men as the Chairman of the Shipping Board, the Director General of the Emergency Fleet Corporation and the head of the company that is building the ship, which, in part, were as follows:

"The launching of the *Quistconck* marks the beginning of an epoch in the nation's history. The men who have worked on this ship, and those who are working on other ships for the Emergency Fleet Corporation, are the makers of a new America. Through the efforts of the shipyard workers, a large American army is now in France, and through their continuous work this army, steadily growing larger and larger, eventually will overwhelm the carefully constructed military programme with which Germany has planned to dominate the world."—*Edward N. Hurley, Chairman, United States Shipping Board.*

"Never before has there been such a big demonstration at any launching in the United States. It is probable that there never will be another, but the enthusiasm shown here will never die. The launching of the *Quistconck* brings to a successful completion the first unit which will be turned out through American workmanship and ingenuity at the world's greatest shipyard."—*Charles M. Schwab, Director General, United States Shipping Board Emergency Fleet Corporation.*

"The launching of the *Quistconck* marks the passing of Hog Island from a constructive undertaking to a manufacturing plant, to be operated at its full capacity for the manufacture of ships. From now on, as long as our country may require it, ships will be manufactured in quantities.—*Charles A. Stone, Chairman, Board of Directors, American International Shipbuilding Corporation.*

Pennant Winners

THE Hog Island yard was not alone in gathering in honors last month, however, for the Merchant Shipbuilding Corporation at Harriman, Pa., also launched its first vessel, and now all of the great government yards established for the assembling of fabricated steel ships have reached the stage of schedule production, which will greatly increase the output of American shipyards during the coming months. That startling results are assured is shown by the patriotic enthusiasm with which every shipyard in the United States is striving to secure the coveted privilege of flying the pennant flags awarded by the Shipping Board for the best monthly record in production. In both May and June the honors went to the Pacific Coast, but this result has only stimulated shipbuilders in other parts of the country to put forth every effort to beat the splendid records of their friendly competitors on the Pacific Coast. For June, the awards were as follows: (steel ships) first pennant, Skinner & Eddy Shipbuilding Corporation, Seattle, Wash.; second pennant, Bethlehem Shipbuilding Corporation (Union plant), San Francisco, Cal.; third pennant, Columbia Shipbuilding Company, Portland, Ore.; (wood ships) first pennant, Grant, Smith, Porter Ship Company, Aberdeen, Wash.; second pennant, Smith, Grant, Porter Ship Company, St. Johns, Portland, Ore.; third pennant, White, Seaborn Shipyards Company, Tacoma, Wash.

Steel Requirements

AT a recent meeting of the War Industries Board the question of government steel requirements was thoroughly discussed, with a view to meeting, if possible, every actual demand for steel for war purposes. The largest of the government steel requirements are, first, for the railroads; second, for the shipbuilders; third, for the War Department, and fourth, for the Navy. The question of supplying these demands so effectively that there need be no curtailment of actual war activities was put squarely before the steel makers and all others concerned in any way with steel production. As a result of this conference, it was decided that there must be: First, greater conversion of mills to the production of steel required in the war programme; second, an increase in the supply of coal, particularly by-products coal, available for mills engaged in war work; third, the shutting off of further steel shipments to industries other than those engaged in meeting war needs, and fourth, more rigorous conservation in the handling of steel in the mills.

It is a pleasure to record that the steel men not only promised to co-operate to their utmost in meeting the government needs, but virtually pledged themselves so to in-

crease their output as to guarantee the requirements of the war programme. Notwithstanding this praiseworthy attitude, there still remains the fact that new needs at the battlefront in France have added to the gap between capacity and requirements in the steel industry. According to the *Iron Age,* the requirements for the last four months of the present year will bring the total for the second half of the year up to 23,000,000 tons, as against an estimate of 20,000,000 tons early in June and a probable production of from 17,000,000 to 18,000,000 tons for the six months. It is to be hoped that with a better understanding of the specific needs the shipbuilders at least will not be handicapped by lack of ship materials or serious delays in delivery.

Motorships Coming Into Their Own

By awarding contracts for the construction of thirty-six steel, twin-screw, Diesel-engined motorships of about 5,000 tons deadweight carrying capacity each, the Emergency Fleet Corporation has given a decided impetus to the motorship and marine oil engine industries in this country. The hulls of these vessels will be of special design, the material for which will be fabricated in structural steel shops and erected in shipyards on the Atlantic and Pacific coasts. The vessels will be 334 feet 9 inches long over all, 333 feet between perpendiculars, 46 feet beam, 29 feet 9 inches molded depth, and at a draft of 21 feet will have a displacement of about 7,100 tons. With a total shaft horsepower of 1,500, developed on two shafts, the vessels will have a speed of from 10 to 10½ knots.

In twenty-six of the vessels ordered, the main propelling machinery will consist of McIntosh & Seymour, six-cylinder, Polar, trunk piston Diesel engines, with cylinders 22 inches diameter and 32 inches stroke, designed to operate at 130 revolutions per minute. Each engine will weigh about 100 tons and will develop about 750 shaft horsepower. In ten of the vessels the main propelling machinery will consist of two six-cylinder, Skandia-built, Werkspoor Diesel engines, with cylinders 20½ inches diameter by 35½ inches stroke. These engines will develop the same power and run at about the same speed as the others, but will weigh only about 96 tons. Both types of engines are single-acting, direct reversible, of the four-cycle type, but the Werkspoor engines are built in accordance with steam practice with crossheads and guides. All the auxiliaries will be electrically driven, current being supplied by Diesel-engined generating sets.

Some of the ships of this type, it is understood, will be fitted with steam propelling machinery, so as to give an opportunity for direct comparison of the two methods of propulsion. With the motor installation it is estimated that the daily consumption of fuel will amount to about 6½ tons. As each vessel will have a total fuel capacity of 976 tons, with provision for carrying an additional supply if necessary, the motorships will have a possible cruising radius of about 40,000 miles.

This initial Government order for motorships will be welcomed by American shipowners, as eventually it will furnish some badly needed information regarding the reliability of American-built marine Diesel engines and will tend to substantiate or disprove the claims of manufacturers of this type of propelling machinery. No one disputes the theoretical thermal efficiency of the Diesel engine or its possible savings in fuel consumption, but the limited experience which American shipowners have so far had with such engines designed for cargo vessels has failed to justify a feeling of confidence in their reliable performance under all conditions of sea service and the consequent overall economy of such installations. If the design or workmanship of the engines is at fault in any way, the trouble will be manifest in poor efficiency or breakdowns, and in such cases the time lost and expense of repairs, readjustments and replacements will soon offset the theoretical gains. Proper installation and skillful operation are essential for success in Diesel-engined vessels, and we sincerely hope that no precaution will be overlooked to make these first government motorships give a good account of themselves. If the motorship advocates' claims are sustained in this case, a bright future is in store not only for American oil engine builders but more especially for American shipowners, to whom the principal advantages will accrue.

Status of the Concrete Ship Programme

Numerous articles regarding the design and construction of reinforced concrete ships have been published in recent issues of Marine Engineering to show what has been accomplished in this new branch of shipbuilding, both in the United States and abroad. That concrete shipbuilding will find a limited field of usefulness in the present emergency seems assured, but its future as a competitor of the steel shipbuilding industry is confronted with too many obstacles and uncertainties to warrant its extended adoption at the present time. In the first place data are lacking regarding the behavior of a concrete steam or motor ship in ocean service, except for vessels of small size, and that is too limited to form a secure basis for future assumptions. For vessels of large size the concrete ship is handicapped by greater weight and the uncertainty of the effect of the stresses encountered at sea on the various forms of construction proposed. Estimates of cost are also based upon assumptions as yet not borne out by practice. But in the United States, at least, the status of the concrete shipbuilding industry is dependent upon other factors outside of the question of the construction of the hull itself, which apparently have been overlooked or misunderstood by the concrete ship advocates, who, for the most part, are not experienced shipbuilders. The situation has been clearly explained by both the Director General and the General Manager of the Emergency Fleet Corporation.

Mr. Schwab rightly says that small ships are not economical for trans-oceanic service and that for large vessels we must rely upon steel. Until we have built some 7,500-ton concrete ships, which we are doing to-day, and tried them out, we would not be justified in diverting energy, material and labor from what we are sure of. Besides, at the present time our principal trouble is in getting fittings, which also would be required for concrete ships, and added construction in this field would only accentuate these difficulties.

Mr. Piez further points out that to-day the hull-producing capacity of the country in steel and wood ships is in excess of what may be termed the power and equipment-producing capacity for fitting out ships. Furthermore, as a carrier, the steel ship is admittedly from 15 to 20 percent more effective than a wood or concrete ship of similar tonnage. Although the output of steel and wood ships is constantly increasing, we have not yet reached anything like the possibilities of output in steel construction. It should be remembered that in the building of a ship of any type, only 60 percent of the total labor is connected with the hull and that fully 40 percent of the total labor input, and that the most highly skilled and the most difficult to obtain, is connected with the installation of machinery and equipment.

Until the concrete ship advocates are prepared to build and install the machinery and fittings as well as the hull, it would appear that their efforts to supplement the steel ship programme are misdirected.

American Ships for Foreign Trade

Great Merchant Fleet Will Open New Opportunities for Manufacturers in Foreign Trade—Stirring Appeal to Business Men

BY EDWARD N. HURLEY*

WITH something like 25,000,000 tons of merchant shipping to be employed inside of two years, the United States Shipping Board feels that it is none too early to look around for cargoes, both in this country and abroad. With the task of building the ships in charge of the Emergency Fleet Corporation, under the leadership of Charles M. Schwab, this function of the United States Shipping Board begins to attain prominence—and that is what the Shipping Board was originally created for by Congress.

Shipping Available in Two Years

Twenty-five million tons is a lot of shipping. In one voyage these ships would carry all the live stock, dressed meats, packing-house products, poultry, game, fish, wool, hides and leather carried on our railroads in one year. In less than five trips they would carry our whole yearly railroad haul of grain, flour, cotton, hay, fruit, vegetables and other farm products; in three and one-half trips all our lumber; in seven trips all our manufactured goods; in sixteen trips all our coal and coke. The total tonnage hauled on our railroads is about 1,200,000,000 tons.

So, amid all his splendid effort in producing equipment to win the war, the American manufacturer must be asked to take thought for to-morrow and think in terms of shipping and foreign trade. This might appear like a distraction now—something which will take the attention from the supreme duty of winning the war. But far from being a distraction, it fits in with war production and war psychology. While our factories and factory employees are building war material to-day, they are also building foreign trade, if we can only see things whole and make one factor work with another.

When the business man turns his attention to export trade he looks abroad and thinks of foreign customers. But foreign trade actually begins in his own factory. He looks abroad and studies such factors as ocean freights, foreign exchange, export packing and international salesmanship. If he would look into his own factory first and study factors close at hand, such as labor turnover, wages, manufacturing costs and efficiency, he would be laying solid foundations for export trade.

Manufacturing "Effectiveness"

In a recent study of factors that make successful, lasting foreign trade, Professor Taussig places first of all the element of manufacturing "effectiveness," as he calls it, which he defines as a combination of capital, labor, invention, salesmanship and transportation, all working together under first-rate business leadership, to make goods capable of holding markets in competition with the products of other nations. These elements of effectiveness are largely right at hand in our factories—it is not necessary to send anybody abroad to find them. And as an illustration of how nations make mistakes in trying to build foreign trade at the other end, Professor Taussig shows that real effectiveness in manufacturing almost invariably holds its own against artificial devices for building foreign trade, such as export bounties, special railroad rates on export shipments, cut prices, discriminatory tariffs, etc.

With the bugaboo of cheap foreign labor haunting us in former years, we got into the way of thinking that export trade necessitated some lowering of wages and American living standards. Probably that was crooked thinking before the war. Certainly it is crooked thinking now, for the war is bringing other nations closer to our American standards of wages and living.

True development of foreign trade in our factories means better and better American standards.

In most of the countries of the world there will be a decided shortage of labor after the war. That country will best succeed which protects its workmen by improving their living conditions, guaranteeing a fair return for labor, protecting workmen and their families against accidents and idleness, and making workers better citizens. The country taking those measures will be the country that develops and makes products most economically, and will perform a world service by making goods at the prices fair to other nations.

Mobilizing Man Power for Foreign Trade

Nobody has yet suggested sending cheap American soldiers over to France to win the war. Our men at arms are the pick of the country, physically and mentally. We take plenty of time to train them, make them specialists in every branch of fighting. We study them individually to find which are best suited for flying, or signalling, or bombing, or bayonet fighting. We recognize that modern war is a swift game, constantly changing, and that our soldiers must be prepared to learn new trades and new tricks from month to month, and we get ready to teach them these new trades and also put them in a receptive attitude toward improvements in the fighting game. We feed them like fighting cocks and spare no expense in clothing them or providing the latest fighting tools.

In the army and navy we have a visible mobilization of man power for results in a foreign country. If we could have the same visible mobilization of man power in our factories for foreign trade it would be a splendid object lesson for those who manage the factories and make the export goods.

To think of cheapness in connection with foreign trade is just as wrong as trying to pin bargain tags on soldiers. Foreign markets are not going to be won or held by cheapened American workers or bargain methods in American life. As manufacturers, we have got to lay the foundations for foreign trade by going out into our factories and studying labor and costs together. We can sell our export products at reasonable prices by increasing wages along with output and decreasing the losses caused by labor turnover, untrained workers, spoiled materials and other inefficiency.

Our experience along these lines in the Emergency Fleet Corporation has been most encouraging. With the task of creating new shipyards in a few months and manning them with several hundred thousand workmen, most

* Chairman, United States Shipping Board.

of whom came from other trades, we ran into about every difficulty, and problem, and tangle, that could conceivably arise in management. On a large scale we effected an adjustment of man power such as is called for now in preparing the average American factory for the export trade which we will need to keep our ships employed.

Co-Operation with Workers

To get production at unheard-of speed and in record-breaking quantity, we did something simple and fundamental—and thoroughly human. This was nothing more nor less than arranging wages so that, while our workers produced more for us, they were also able to produce more for themselves. We established the rule that a piecework wage rate set by any shipbuilder must stay in force during the period of the war. Any manufacturer who sets a piecework rate and then reduces that rate if he finds that he has made a mistake against himself is doing a great injustice to his employees. Profiting by our experience in the shipyards, I should like to see Congress pass a Federal law making it compulsory to keep every piece rate in effect one year. That would protect workers and furnish a real basis for increased production.

Reducing Labor Turnover

We found ourselves confronted with enormous losses and dangerous delays through lack of skill by workers in special trades needed in the shipyards and also through the cost of labor turnover. To find 100 capable shipbuilders who would stick on the job, it was necessary to hire and try, discharge or lose 1,000. Every manufacturer will recognize in these difficulties exactly the difficulties that he himself faces from day to day, and which put excessive burdens of cost upon his products. In the shipyards we got around those difficulties by establishing training centers for the various trades we needed, and also by appealing to the splendid spirit which lies in the average worker. We had to train everybody, from the boy who heats rivets right up—foremen and superintendents, and even executives. Starting with a little nucleus of skilled riveters, calkers, reamers, carpenters and so forth, we took them out of the shipyard for a time and taught them how to teach their trades to others. Then they went back into the yards to teach green recruits, not in any school or class, but on actual ships, while doing the regular day's work. Under this system it was possible quickly to bring green gangs up to about 80 percent of the efficiency of skilled workmen. As fast as these men learned their trades and acquired high earning power under our protected piece rates, they became steady enough, and the costly item of labor turnover began to drop. After that nothing more was needed but the appeal for patriotic service. We found that the shipworkers would not only stick on the job like soldiers, but that in their inherent spirit as fighters and loyal Americans there was an enormous reserve of man power to draw upon—a reserve capable of meeting every demand and every emergency, with power to spare.

Wake Up, American Business Men!

That reserve of spirit exists in every American industry. War has brought it to light where executives can see it, and to develop this great reserve for foreign trade is distinctly the executive's job.

To fill our merchant ships with goods after the war and hold our own in foreign markets, we must begin now to mobilize and train our man power in manufacturing along the same broad lines followed in training for military purposes. Wake up, American business men! Begin to study the man power in your own organizations—not with the Prussian viewpoint, which counts human life its cheapest raw material in both the factory and the fighting line, but with the American viewpoint of decent living, opportunity, humanity, service.

Magnitude in Present-Day Construction Work

Size and speed distinguish most of the present-day undertakings in the construction field. Contracting firms that four years ago would have looked upon a million-dollar contract as large are to-day as readily undertaking work that runs up into the tens of millions, are handling men by the thousand and material in heretofore unheard-of quantities.

The following authentic figures regarding the largest destroyer plant in the world at Squantum, Mass., are, therefore, of peculiar interest. This plant, built by the Aberthaw Construction Company, of Boston, for the Bethlehem Shipbuilding Corporation, Ltd., was started in October of last year and the work carried through to completion during one of the most severe winters that New England has ever known.

The site when the builders started work consisted of a marsh with a few areas of upland here and there that were slightly above high-tide level. In order to make land on which to build buildings, one and one-quarter million cubic yards of filling had to be deposited upon the land. About two-thirds of this quantity was dredged up from the harbor by the dredges which were forming the launching basin and channel that connects with the main ship channel. The remainder of the material was dug by steam shovels in various adjoining gravel pits. In order to move this amount of material a travel of 140,000 car miles was recorded.

Five thousand freight cars full of building material were brought to the job. An idea of the amount of this material can be gained if it is remembered that these cars placed end to end would reach from Boston to Worcester, and that in addition 50,000 truck loads and teamloads of material of various kinds were brought over the road.

Most of the buildings are built upon piles, about half a million lineal feet of wood and concrete piling being driven. The steel framing of the buildings called for 11,000 tons. The area of the roofs of the buildings amounts to 30 acres, and the perimeter of them is just under three miles. There are twelve acres of window glass in the job, requiring 110 tons of putty to fasten it in place. Six miles of standard gage railroad track were laid around the building and in connecting the plant to the New York, New Haven & Hartford main line.

The wood roofs, wharves, docks and temporary buildings called for a total of 10,000,000 board feet of lumber, the bulk of which was cut in the South. Thirty miles of piping were needed in order to take care of the needs of water and sewerage, steam, compressed air, fuel oil, sprinkler lines and fire mains, and 16,000 sprinkler heads to protect the buildings from fire. Eight thousand gallons of paint were needed for windows, steel and woodwork.

For carrying through the great undertaking the Aberthaw Construction Company added quickly to its permanent organization enough men to make up a total of nearly 6,000. They have now under way for the same clients a far larger undertaking on the Pacific coast that may eventually call for the work of 20,000 men.

Manning the New Merchant Marine

Free Schools Established for Training Deck and Engine Room Crews for American Ships—Details of the System Explained

BY HENRY HOWARD*

PRESENT construction plans for our merchant marine call for more than 14,000,000 tons of new shipping, to be completed within two years.

At the beginning of the world war, in August, 1914, seven nations were credited with more than 1,000,000 tons of shipping each. Great Britain headed the list with 19,799,119 tons; the United States stood next with 7,928,688 tons, and Germany third with 4,892,416 tons, the other nations standing: France, 2,173,544; Norway, 2,425,476; Sweden, 1,114,048, and Japan, 1,167,264. Austria had less than 1,000,000 tons, with 988,130. Of the tonnage of the United States, something more than 2,000,000 tons was available for deep-water service in the Atlantic.

The first year of the war was sufficient to show the United States that the process of attrition in the world's supply of tonnage was creating a shortage of ships. This shortage became acute when the United States entered the war, thereby adding to this country's vast needs of sea transportation of troops and supplies, and the quickened need of sending more and yet more supplies to our Allies. Indeed, steps had been taken for developing our merchant fleets some months before with the creation of the United States Shipping Board, by Act of Congress in September, 1916. Accordingly, when the United States entered the war it was ready to exercise its functions as sponsor for a new, nationalized merchant marine. Immediately the country had become a party to the war, suggestions poured in on the Shipping Board as to ways and means of adding largely and rapidly to the nation's tonnage in merchant ships.

Organization of the Training System

Coincident with the sudden awakening of the nation to the vital need for more cargo ships, and the energetic initial steps of the Shipping Board to produce them, came forward the important question of manning the new merchant marine so soon to come into being. The country as a whole was unaccustomed, in recent times, to thinking in terms of shipping and appeared doubtful of its ability to produce the mariners needed to handle its new fleets. We were no longer a sea-going people, said the doubtful; we had lost the art of the sailor when the American square-rigged ship went out of use as a leader among the world's cargo carriers. Surely, our war need was pressing enough to appeal to the patriotism of Americans with a liking for the sea, but would any considerable numbers come forward for service on merchant ships?

Relatively few men who had a knowledge of maritime affairs and a broad view of the trend of events in the world war were able to grasp both the needs of the hour and the means of meeting them—to take an optimistic view of our country's ability effectively to turn back to the sea, where it won its first laurels in commerce. Such men there were, however, in the United States Shipping Board when that body was approached with a plan for manning our new merchant fleets.

The plan provided, in brief, for a training system to prepare Americans for service on American merchant ships, the work to begin with the training of officers and eventually to extend to the training of crews. Among the many thousand fishermen on our coasts—not less than 100,000 on the Atlantic and Gulf seaboards alone—could be found excellent material for merchant officers and sailors. Furthermore, former sailors were to be found in almost all the states, engaged in various occupations—former captains, mates of sailing vessels, and not a few former officers of merchant steamers. Many marine engineers working ashore and other engineers could also be prepared in a short course of special training for service at sea.

Free Schools Established

By establishing free schools in navigation at important ports, and free classes in marine engineering at some of the leading technical colleges, it was proposed to train enough men of the types indicated to meet the forthcoming increased demand for American deck and engine-room officers for the new American cargo ships.

On May 29, 1917, the writer was authorized by the Shipping Board to inaugurate the training plan, and on June 1 was sworn in as Director of Recruiting Service for the Board. Three days later the first free navigation school to be conducted under the direction of the United States Shipping Board was opened, with twenty students, at the students' astronomical laboratory, Harvard University. Later this school was transferred to the Massachusetts Institute of Technology, where it has since been maintained.

The work of organizing additional schools went on through succeeding months, until forty-one in all were established on the Atlantic, Gulf and Pacific coasts and the Great Lakes. The response of men qualified to enter the schools was quick and gratifying. Many patriotic applicants expressed a willingness to leave lucrative positions ashore in order to fit themselves for service in the merchant marine in war time; others frankly hailed with delight an opportunity to get back to the sea, which they had left because of unpromising conditions in the decade preceding the opening of the Great War.

National Headquarters at Boston

National headquarters of the new training service were established at Boston. For administrative purposes in establishing and maintaining the schools, the country was divided into sections, following closely the geographical divisions employed by the United States Steamboat Inspection Service, which from the first co-operated heartily with the Recruiting Service of the Shipping Board in maintaining the standard set by the regulations of the Department of Commerce. The Board was fortunate in securing as section chiefs men of professional or business training, whose patriotism led them to donate their time to this service. The section chiefs of the service are as follows: Section I, Mr. Horatio Hathaway, Jr., twelfth floor, Custom House, Boston, Mass.; Section II, Mr. John F. Lewis, 108 South Fourth street, Philadelphia, Pa.; Section III, Mr. Hardy Croom, 130 Riverside avenue, Jacksonville, Fla.; Section IV, Mr. Ernest Lee Jahncke, 814

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Howard avenue, New Orleans, La.; Section V, Mr. Farnham P. Griffiths, 465 California street, San Francisco, Cal.; Section VI, Mr. William J. Grambs, 860 Stuart building, Seattle, Wash.; Section VII, Capt. Irving L. Evans, 933 Guardian building, Cleveland, Ohio.

System of Instruction

Direction of instruction in the navigation schools was placed in the hands of Professor Alfred E. Burton, dean of the Massachusetts Institute of Technology, who formerly was connected with the Coast and Geodetic Survey, and who is a practical navigator of wide scientific knowledge. Professor Burton selected his instructors from among men of practical training, among them astronomers, explorers and former sea captains with recognized standing as teachers.

By the system of instruction perfected for the schools, comprising the most approved methods of teaching navigation, it was possible to impart to a student in a six-weeks' study a groundwork of the theory and practice of navigation to enable him to pass the examination of the United States Steamboat Inspection Service, entitling him to a license as a second or third mate. After passing the examination, the student in need of practical experience on a steamer was sent to sea in the capacity of a reserve officer, for a period of two months, to learn the ropes before actually assuming the full responsibilities of the position for which he was licensed.

Since the opening of the first school in navigation by the Recruiting Service of the Shipping Board, thirty-nine others have been opened.

The graduates from these schools, in the ten months from June 1, 1917, to April 1, 1918, numbered 1,500.

Engineering Schools

The training of engineers was placed in the hands of Professor Edward F. Miller, of the Massachusetts Institute of Technology, and classes were established at Massachusetts Institute of Technology, Stevens Institute of Technology, Bourse building (Philadelphia), Johns Hopkins University, Tulane University of Louisiana, Case Schools of Applied Science (Cleveland), Armour Institute of Technology, University of Washington.

The school at Stevens Institute of Technology was later discontinued and one was started at the Seamen's Church Institute in New York City.

The course in the engineering schools is of one month's duration. The qualifications for admission to these schools differ slightly from those required for admission to the navigation schools, as men with proper technical experience are admitted who may require as much as six months' added training at sea before becoming eligible for licenses.

About 1,200 marine engineers were graduated from the Shipping Board free engineering schools in the first ten months of their existence. Like the deck officers graduated, all were American citizens.

One noticeable effect of the Recruiting Service's call for Americans qualified to serve as officers in the new merchant marine was the stimulation given men qualified to take examinations for licenses, without special schooling. Not less than 3,600 original licenses were issued in that period—including those issued to the men specially trained by this service.

The Sea Service Bureau

The Sea Service Bureau was established as a necessary adjunct to the training service for officers. Graduates of the schools were placed on board ship by this department, at first entirely through the co-operation of private steamship interests, and later also on ships controlled directly by the Shipping Board. The work of this bureau showed at an early stage that without the supply of officers created by the Shipping Board schools there would have been at times in 1917 a shortage of mates and assistant engineers for American merchant ships, even before the Shipping Board's construction programme produced new vessels. Representatives of the Sea Serice Bureau established in various important ports exercised increasingly broadened functions in placing American officers and crews as the demand for them increased with the launching of increased numbers of merchant ships.

Training Merchant Crews

By the autumn of 1917 the construction programme of the United States Shipping Board, by which considerably more than 2,000 new ships will be commissioned under our flag, had advanced sufficiently to warrant the development of the second phase of the training plan—the training of crews.

Much thought was given by the Recruiting Service staff to working out a system of intensive training for crews by the use of a squadron of training ships. On December 12, 1917, announcement was made that the Recruiting Service was prepared to receive applications from young Americans between 21 and 30 who wished to be trained for service on merchant ships. In the three months following this announcement more than 7,500 applications were received.

The number of men required for this branch of the training service was at first estimated to be 85,000, but events subsequently led to a modification of this figure. At this time the need of arming all ships entering European waters with naval guns led to a proposal that all ships crossing the submarine zone be manned by the navy. After conferences on this point between officials of the Navy Department, the War Department—then operating the troop ships—and the Shipping Board, a decision was reached by which control of troop ships, animal transports and freighters carrying unbroken cargoes of munitions and supplies for military uses were placed in control of the navy, to be manned by naval crews, while Atlantic passenger liners, freighters with general cargoes for our Allies, and all merchantmen plying outside the war zone were left in the control of the Shipping Board. This arrangement imposed onto the Shipping Board the work of training many thousand young men for crews on these vessels. To administer the training service, a department was created termed the Sea Training Bureau, with a supervisor of training in charge.

Training Ships Provided

Two steel screw steamers were at once secured—the *Calvin Austin* and *Gov. Dingley*, twin ships, formerly in the passenger trade on the New England coast, each 3,800 tons gross register, 299 feet long and 60 feet wide, with reciprocating engines and 2,700 indicated horsepower. When converted into training ships, the vessels each had capacity for from 500 to 600 apprentices. While those two ships were being filled, a third, the former transport *Meade*, ex-*City of Berlin*, was being fitted out at Newport News. This was a graceful old Atlantic liner, with a sound hull and capacity for something more than 1,200 apprentices. Later a fourth ship, the *Gov. Cobb*, of the type of the two first named, was put into the training squadron, and plans were put on foot for placing a training ship on the Pacific Coast and another at New Orleans.

The training course is of an intensive character. There is an instructor to each ten apprentices, who is held responsible for the progress of his group. The apprentices virtually go to school all day, and every day, except Sunday, during their stay on the ship, which is not less than a month in any instance, and probably exceeds two months in a few cases. Daily routine begins at 6 A. M. with "All hands tidy room," and ends at 9 P. M. with "Turn out all lights." The recreation period from 6 to 9 P. M. includes singing of the old-time chanteys, in which the young men are instructed by a veteran deep-water chantey man.

When the apprentices have finished their intensive training they are added to regular crews in the merchant marine, on a given ratio to the experienced men carried. By this method it is expected that no difficulty will be experienced in securing full crews for all new ships added to the merchant fleet by the Shipping Board, as well as for any existing ships that may need men.

Port of New York Capable of Expansion

Present Volume of Overseas Commerce Through New York Can Be Doubled—Investigation by Port and Harbor Development Commission

THE port of New York can handle more than twice its present volume of business, according to the New York, New Jersey Port and Harbor Development Commission. Contrary to the impression created by last winter's congestion, the Commission officially announces that the studies and investigations already made demonstrate the fact that the capacity of this port for the handling of outgoing and incoming tonnage equals several times the present extraordinary war demands upon our port facilities.

This important official statement of the Commission appointed by Governor Whitman and Governor Edge last year and of which William R. Willcox, of New York, is chairman, and J. Spencer Smith, of New Jersey, vice-chairman, is based on the broadest and most searching and scientific survey and study of port facilities, of the operations and of the needs of the port of New York, that has ever been made.

The importance of the Commission's announcement is of particular significance, as it makes absurd the claim being made by interests located in other Atlantic seaports that the limit of New York's port facilities has been reached. The survey has disclosed the main causes leading to last winter's congestion, which is the basis of all reports alleging that the full capacity of the port of New York has been reached. These causes, Chairman Willcox declares, were due to abnormal weather conditions, lack of steamships, coal shortage and the absence of anything approaching co-ordination or co-operation in the tremendous shipment of raw materials toward the end of last year.

Chairman Willcox's Statement

Speaking for the Commission, Chairman Willcox said recently at the office of the Commission, 115 Broadway, that the port of New York has a water-front length of 770 miles, of which 320 miles have been developed. Of the 450 miles remaining for development, at least 50 miles are located in almost the exact center of this port.

"The Commission has already obtained," said Chairman Willcox, "through its experts and investigators in the field and in the records of the carriers, a large amount of data and information which clearly indicates that the port of New York, if properly developed, will be able to handle several times the amount of freight now entering and leaving the port.

"For the first time this Commission will have placed before it correct statements as to the present cost of passing commerce through this port.

"This information is fundamental, and it has never been known in the past what these costs were; until these costs are known it is impossible to make an economic proof of the necessities of additional facilities at the port and more scientific methods of conducting commerce.

"All of this work is being performed in the working office of the Commission located at 14 John street, New York City, which is under the direction of the consulting engineer of the Commission, B. F. Cresson, Jr.

"The problems presented by this port are more complex and involved and of vastly greater magnitude than those existing in any other seaport.

Nine Trunk Railroads Terminate in New York

"We have, for instance, nine trunk lines having separate terminals here. Our system of investigation requires that each of these be studied separately, and our groups of experts, statisticians and inspectors take up one unit after the other and secure first-hand and absolutely authentic records and make checks from the books of the respective railroad or corporation. One of our first steps was to have conferences with presidents and executive officers of the trunk lines and shipping interests using the port.

"We are investigating and resolving into maps, charts and records every other interest affecting port use or the use of its facilities. Our experts are studying truckage freight movements and the causes of delay in handling freight, and we have under way a survey to locate a belt line in New Jersey for the interchange of freight outside the congested Hudson River area. Other experts are at work on the electric power situation in New York; on the facilities for interchange of commerce on the New York Barge Canal; on barge canal terminals; locations for supplemental terminals; on coal bunkering and local coal deliveries. We will also take up inquiries into methods and regulations pertaining to pilotage, stevedoring, weighing, public and private ferries, sewerage disposal and the purification of harbor waters, the handling of building materials, the handling of grain, the disposal of municipal wastes, available warehouses, lighterage, markets, and the distribution of food products, ice, the methods of financing our commerce, and many other elements of the problem.

"The scope of our work comprehends every interest making use of the port. It is therefore national in its importance. I may say, in conclusion, we believe that the Federal government realizes and appreciates the wide range and practical aspects of our investigations."

Why is a "dollie bar" and where did it get its name? Speak up, somebody!

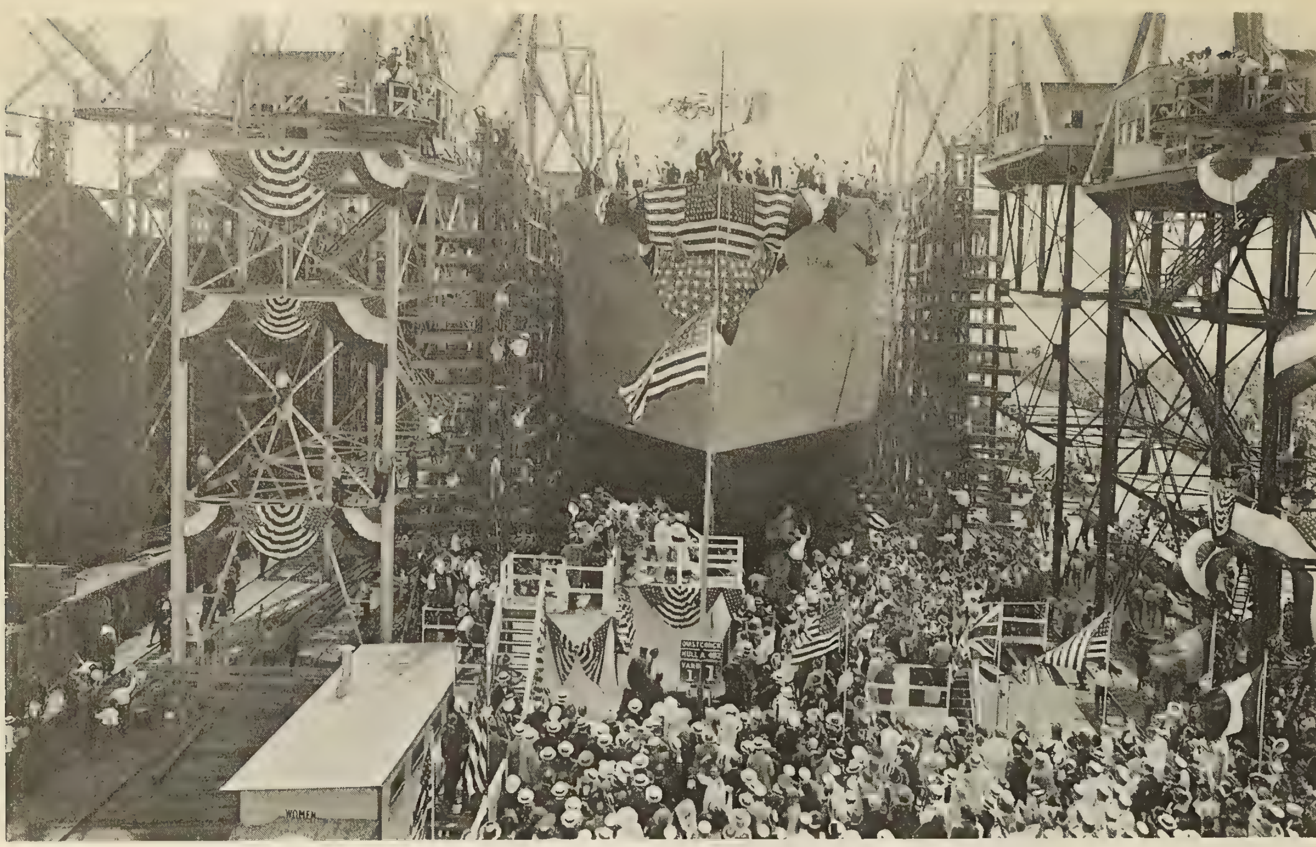


Fig. 1.—Launching the First Vessel at Hog Island

Fig. 2.—A Section of the Crowd that Witnessed the Launching of the *Quistconck* at Hog Island on August 5.

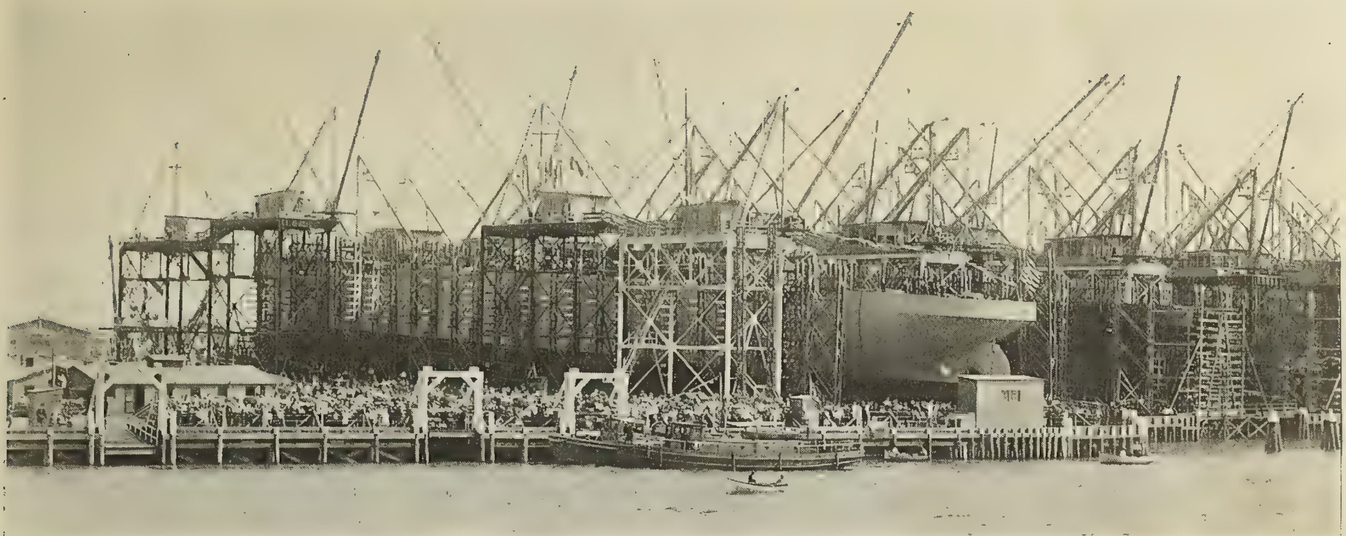


Fig. 3.—View of the *Quistconck* on the Ways Before Launching

Hog Island Yard Launches Its First Ship

Seventy-Five Hundred-Ton Deadweight Steamship Quistconck Launched on August 5—Christened by Mrs. Woodrow Wilson

THE launching of the first vessel at Hog Island on August 5 marked the beginning of actual production in the latest and the greatest of the government assembling plants, where fabricated steel cargo ships are being built for the Shipping Board. The vessel was christened *Quistconck* by Mrs. Woodrow Wilson in the presence of President Wilson, government officials, officers of the Shipping Board Emergency Fleet Corporation and many of the leading shipbuilders on the Atlantic Coast, together with over fifty thousand spectators.

The launching ceremony was impressive, not only because of its simplicity and dignity but also because of the business-like spirit which characterized the event. Less than half an hour sufficed to complete the official ceremony, and immediately following the launching the keel of another vessel was laid on the same shipway.

The Presidential party arrived at the yard on a special train from Washington at 12:30 P. M., and six minutes later the vessel was launched. The usual programme of speechmaking was entirely dispensed with, although a luncheon was served to the guests of the company at the head of the shipways.

The *Quistconck* is a single-screw, steel cargo vessel of the two-deck type, with bridge, forecastle and poop. The length over-all is about 401 feet, and the length at the load waterline 390 feet. The molded beam is 54 feet, the depth to the second deck 23 feet, and to the upper deck 32 feet. At full load displacement the draft is about 24 feet.

The vessel is designed for a deadweight capacity of 7,500 tons, the total displacement loaded being estimated at 11,200 tons. According to estimates the weight of the steel hull is 3,100 tons; of the machinery with water, 460 tons; of the wood and equipment, 140 tons, and the total weight of the ship, light, 3,700 tons. There are 380,000 cubic feet of cargo space and the gross tonnage is estimated at 5,400.

Propulsion is by single screw, driven by a geared turbine of 2,500 shaft horsepower, supplied with steam at 200 pounds per square inch pressure from three oil-fired watertube boilers, with a total heating surface of 9,075 square feet, operated under natural draft.

The main turbine is designed to operate at 3,600 revolutions per minute, driving the main propeller shaft through a double helical, double reduction gear at a speed

Fig. 4.—The First Lady of the Land Christens the *Quistconck*

of 90 revolutions per minute. With dry saturated steam at 180 pounds gage pressure at the throttle, a 28-inch vacuum referred to a 30-inch barometer in the condenser, the steam consumption of the turbine, when developing its rated horsepower, is guaranteed not to exceed 12 pounds per shaft horsepower. The vessel has a fuel capacity of about 1,100 tons, and, with an estimated fuel consumption of 29½ tons per twenty-four hours, will have a cruising radius of over 10,000 nautical miles.

At the Hog Island yard practically all of the fabrication of the hull is done in outside shops. The shipyard itself is operated merely as an assembling yard, with sufficient shops and equipment to rectify the fabricating work shipped into the yard which has been damaged, or for replacing parts that are needed. About 80 percent of the hull riveting is done in the yard, and only 20 percent in the fabricating shops.

The hull of the vessel is constructed on the transverse framing system and is subdivided into nine watertight compartments by eight transverse watertight bulkheads, all of which extend to the upper deck. There are four cargo holds, served by five hatches in the upper and second decks and one hatch in the bridge deck.

The original contract awarded to the American International Shipbuilding Corporation on September 13, 1917, called for the construction of a shipyard with fifty ways and the building of fifty 7,500-ton steel cargo steamers of 11½ knots speed. On October 23, 1917, a supplementary order, based on an option in the original contract, was signed for seventy 8,000-ton vessels of similar type, making a total of 120 vessels. On May 7, 1918, a still further order for sixty more 7,500-ton cargo vessels was signed, bringing the total up to 180. According to the terms of the contract the last of the 180 vessels is to be delivered complete by August, 1919. When the yard is in full operation it will have a capacity of 1,500,000 tons of shipping per year.

Fig. 5.—The *Quistconck* Entering the Water

Fig. 6.—First Product of Hog Island Yard Moored at Her Fitting Out Berth

The Most Suitable Sizes and Speeds for General Cargo Steamers*

Method of Determining Most Economical Dimensions of Cargo Vessels for Any Length of Voyage, Condition of Loading and Speed

BY JOHN ANDERSON

From correspondence which recently appeared in a British technical journal on the subject of the best size and speed of general cargo steamers, it appeared to the present writer that there was a desire for some further definition of these qualities, for the different trades upon which vessels are engaged. The conditions induced by the war have made the subject of national importance, as the new merchant fleet which will be brought into being should be such that the best results will be obtained with the minimum expenditure of material, labor, and time.

The ultimate object of all interested in shipping is that the vessels engaged shall transport the maximum amount of cargo in relation to their initial cost, and at the cheapest possible freight rate. The maxima and minima of these requirements are not coincident, and it is therefore necessary to compromise between them.

The initial cost of construction of vessels has varied greatly during different periods of the past, and this has made it difficult for owners having different sizes of ships built at different periods to estimate their relative efficiencies on a common basis; *i e.,* an unsuitable ship built in, say, 1908 might, on account of the very low initial cost, be able successfully to compete against another of better design built in 1913.

With the object of combining the interests of the designer, the owner, and the builder, and of eliminating a number of difficult corrections, the writer has endeavored to formulate a method by which the most economical dimensions can be arrived at for any length of voyage, condition of loading, or speed.

General

The efficient part of a vessel's working life is when transporting cargo from one port to another, and the period spent in loading and discharging, although necessary, can only be considered as lost time. The efficiency of a vessel transporting cargo at a minimum of speed (which will be defined later) can therefore be expressed as—

$$E = \frac{T - t}{T}$$

where T is a convenient total period of time, and t is the proportion of T which is required for loading, discharging, docking, etc.

Size of Vessel

There are many inducements towards building large vessels, the most important of which are—

(1) Reduced initial cost in relation to the deadweight.
(2) Reduced horsepower, crew, and amount of coal required in relation to the deadweight.
(3) Greater seaworthiness.

The problem cannot be considered sectionally, however, and an owner is sometimes prevented from utilizing these advantages fully on account of—

(4) The length of voyage.
(5) The increased length of time required to load and discharge a large ship (which time might for convenience be termed "Detention").
(6) The unsuitability of certain harbors, loading berths, and dry docks.
(7) Greater loss in case of mishap or disaster.

The lost time suggested under item 5 is of considerable magnitude, as the number of hatches or derrick systems which can be arranged in vessels of equal proportions will vary as $\sqrt[3]{\text{deadweight}}$, or, with holds of equal length, the work to be done at each hatch will vary as B, D, H, where B and D are the breadth and depth respectively, H (see Fig. 6) is the average distance through which the cargo has to be transported.

It will be seen from this and the figures in Table I that the average work to be done at each hatch in a 250-foot vessel is about 16,000 foot-tons as compared with 250,000 foot-tons in a 570-foot ship.

Items 1 and 2 represent savings in cost of transportation, whereas item 5 represents loss of invested capital, and it follows that the most suitable size of vessel is that which gives the best economic adjustment between these opposing factors. This can be illustrated diagrammatically.

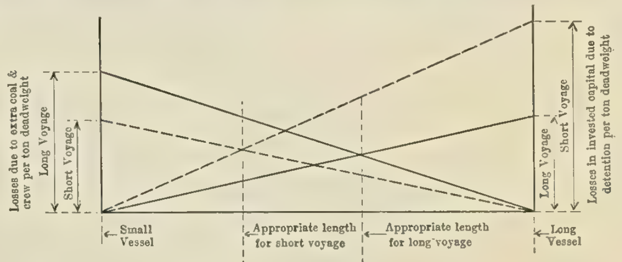


Diagram A

A relatively long voyage or rapid system of loading and discharging will increase the value of E, while an increase in dimensions or an increase of speed for a fixed length of voyage and fixed derrick speed will reduce it, and from these facts it may be presumed that length (or dimensions) may vary in some proportion to E.

Method of Calculating Results

The problem is, to find the dimensions which will give the best compromise between items 1 and 2 and item 5, and in order to obtain information covering a wide field, it was decided to calculate the possible working values of twenty-five vessels, for voyages of 1,000, 4,000 and 8,000 nautical miles, for two speeds of loading and discharging, and for service speeds of 8, 9½, 11, 12½, and 14 knots.

The designs were divided into five groups, each having lengths of 250 feet, 330 feet, 410 feet, 490 feet and 570 feet, and each group was sub-divided to give the speeds already mentioned.

The arrangement of each size of vessel is illustrated on Figs. 1 to 5, and the length of machinery space indicated

* Paper read at the spring meetings of the fifty-ninth session of the Institution of Naval Architects, London, March 20, 1918.

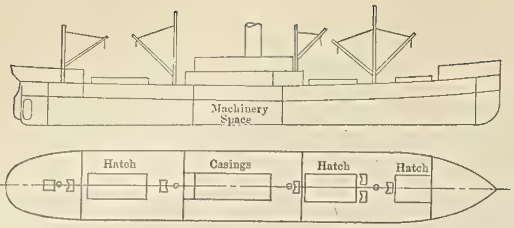


Fig. 1-250′x 37′x 18′6″

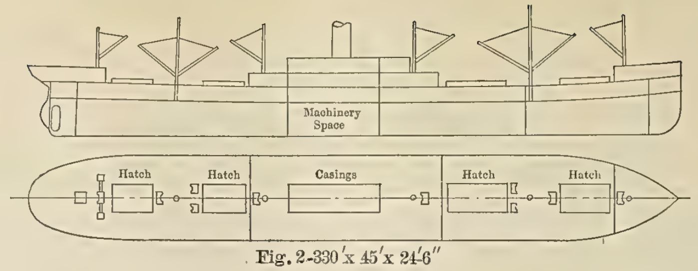


Fig. 2-330′x 45′x 24′6″

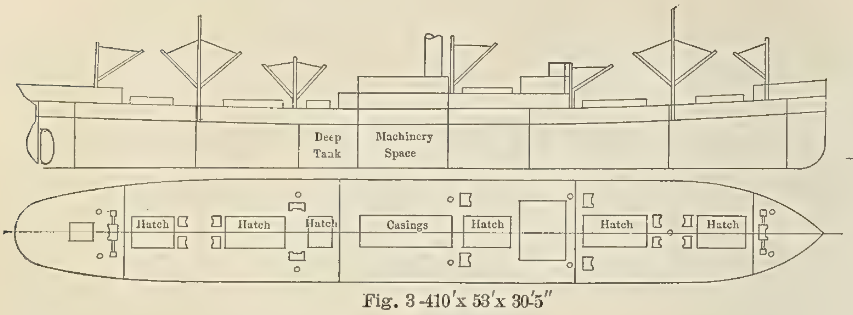


Fig. 3-410′x 53′x 30′5″

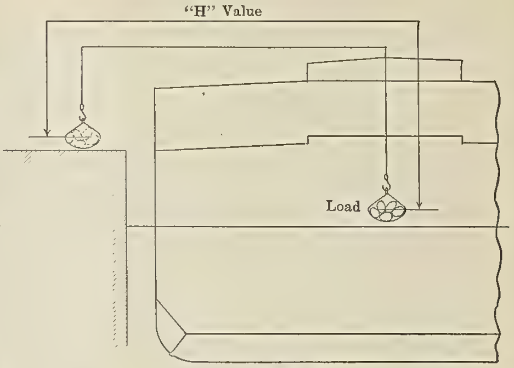


Fig. 6

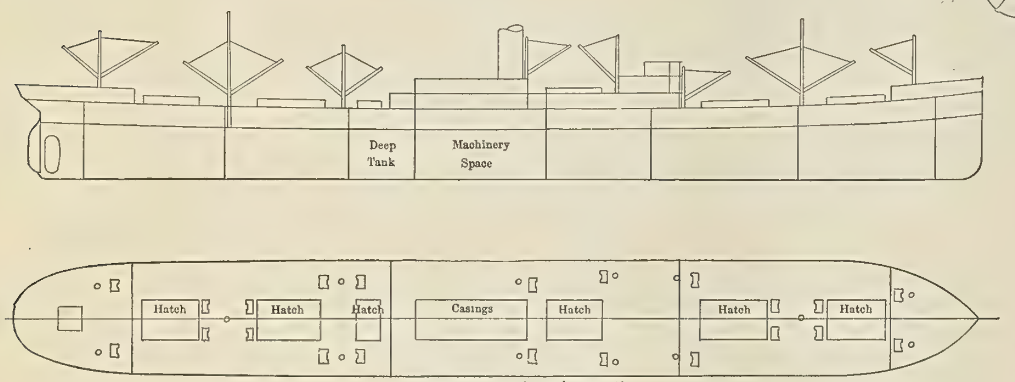


Fig. 4-490′x 61′x 36′4″

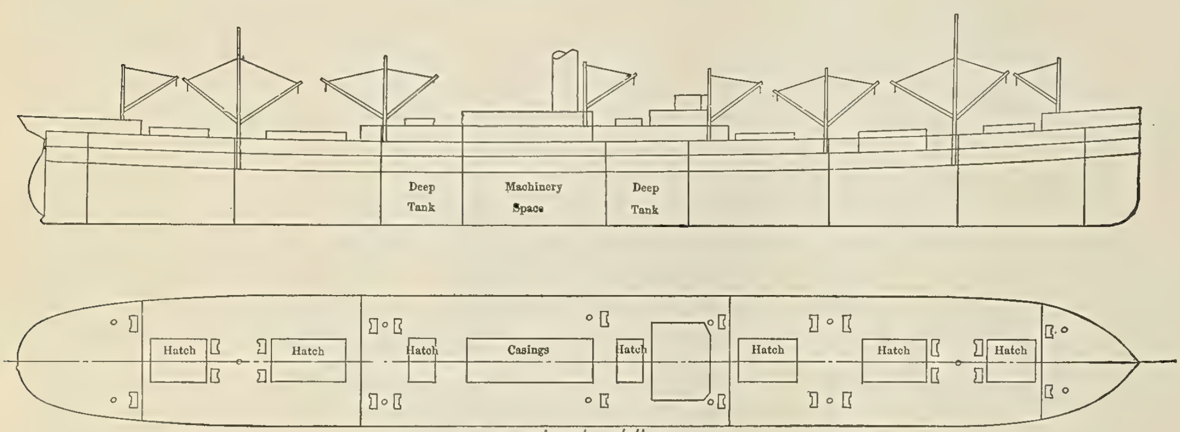


Fig. 5-570′x 69′x 42′3″

Sketches Showing Arrangement of Different Size Vessels

is for a speed of 11 knots. In the vessels above this speed it will be increased in length, but it was assumed that this increase would not affect the number of hatches or derrick systems.

Each vessel is of the poop, bridge, and forecastle type, these erections extending over about 50 percent of the vessel's length. The ratio of length to depth is 13½ times, this being the maximum which Lloyd's will allow with normal scantlings, and it may also be said that this ratio gives the maximum length for derrick arrangements and minimum draft in relation to the deadweight. The breadth has in each case been made equal to $\frac{\text{length}}{10}$ + 12 feet.

The number of winches and derricks systems were arranged to give the maximum number of receiving stations on the quay side, and it was assumed in the calculations that the derricks would be worked on the "yardarm" system if two winches were fitted abreast, and by "swinging" if only single winches were arranged.

It has been assumed that the bulkheads are placed so

TABLE I.—ESTIMATED QUALITIES FOR A VOYAGE OF 4,000 NAUTICAL MILES AND MAXIMUM DERRICK CAPACITY

Item No.	Particulars	Speed of Vessels, 11 Knots				
1	Dimensions	250′ x 37′ x 18′ 6″	330′ x 45′ x 24′ 6″	410′ x 53′ x 30′ 5″	490′ x 61′ x 36′ 4″	570′ x 69′ x 42′ 3″
2	Displacement, Tons	3,031	6,525	11,520	18,360	27,330
3	Draft	16′ 7½″	20′ 9½″	24′ 4¾″	27′ 11″	31′ 7″
4	Block Coefficient	.69	.74	.76	.77	.77
5	Service Horsepower	1,258	1,935	2,540	3,230	4,080
6	Weight of Vessel	1,152	1,934	3,260	5,234	7,515
7	Initial Cost of Vessel	£26,700	£44,700	£66,800	£104,900	£153,700
8	Net Tonnage	700	1,660	3,210	5,400	9,780
9	Crew	24	33	46	56	65
10	No. of Derrick Systems { Yardarm	1	2	7	11	12
	Swinging	4	6	2	......	......
11	Gross Deadweight	1,879	4,591	8,260	13,126	19,815
12	Coal Consumed per Voyage, Tons	389	566	754	978	1,257
13	Stores, Fresh Water, and Feed Water, Tons	61	90	121	161	196
14	Net Cargo Deadweight, Tons	1,388	3,885	7,356	11,987	18,362
15	Days on Run	15.15	15.15	15.15	15.15	15.15
16	Days in Port	2.37	4.15	6.75	8.95	13.09
17	No. of Runs per Annum	20.83	18.92	16.65	15.15	12.91
18	Total Cargo per Annum, Tons	289,10	73,500	122,500	181,600	237,000
19	Total Coal per Annum, Tons	8,102	10,710	12,550	14,820	16,228
20	$\frac{\text{Cargo Transported per Annum}}{\text{Initial Cost of Vessel}}$	1.082	1.643	1.834	1.731	1.542
21	*Cots of Operation per Annum —*	£	£	£	£	£
22	Brokerage and Management, 9d. per ton	1,084	2,757	4,594	6,810	8,888
23	Loading and Discharging, 1s. 6d. per ton	2,168	5,514	9,188	13,620	17,776
24	Coal, Oil, etc., at 12s. per ton	4,861	6,426	7,530	8,892	9,737
25	Tonnage Dues at 1s. 3d. per ton	913	1,965	3,345	5,120	7,904
26	Wages and Provisions	2,017	2,772	3,865	4,705	5,460
27	Depreciation, Insurance, Repairs (1–7 Initial Cost)	3,819	6,393	9,543	14,986	21,964
28	Total Outlay	£14,862	£25,827	£38,065	£54,133	£71,729
29	Profit to give 20 percent on the Initial Cost	£5,346	£8,950	£13,360	£20,980	£30,730
30	Rate per ton to give 20 percent Gross Profit	14s.	9s. 5½d.	8s. 4¾d.	8s. 3¼d.	8s. 7¾d.
31	Efficiency $\frac{T-t}{T} = E$	.865	.785	.692	.629	.536

that the work to be done will be equally divided between the winches or derrick systems.

The time required in port was estimated from the derrick capacity, and to obtain a basis for this it was decided to assume that the maximum amount which could be handled per day of 10 hours in the 410-foot vessels would be 360 tons per "yardarm" system and 276 tons per "swinging" derrick. Proportionate amounts were obtained for the other sizes of vessels by assuming that the time required for hooking and slinging the cargo would be constant, and that the time required for discharging would be proportional to the distance H. On this assumption the following values were obtained:

Length of Vessel.	Working Rate per Day of 10 Hours.	
	Yardarm System.	Swinging System.
250 feet	445 tons	360 tons
330 "	394 "	318 "
410 "	360 "	276 "
490 "	338 "	250 "
570 "	318 "	229 "

The writer is aware that these values are higher than is found in present-day practice, but he purposely kept them high to obtain a wide field and to cover possible future improvements in methods. In order to obtain the lower limit for working rates, alternative calculations were prepared on the assumption that the derricks would be worked at 45 percent of the rates given.

It should be pointed out that as these assumptions are made only for the purpose of calculating E values in relation to the different lengths of voyage, the quantitative working values are not of importance, and the only object in setting off the relative amounts for each size of ship is to show how the larger vessel may be penalized in discharging speed.

Table I indicates the method adopted for calculating the working values of the vessels, and the figures shown refer to the 11-knot speed for each size of vessel. The items are generally self-explanatory, but reference may be made to the following:

(*a*) The drafts are based on present regulations of the Board of Trade, and the block coefficients have been made appropriate to the service speeds. The dictum of the experienced shipowner has been followed with regard to the block coefficient, viz., that it should not exceed .77 whatever the speed may be.

(b) The "weight of vessel" used is that of a bare cargo hull to Lloyd's rules, with engines of triple expansion type, these driving twin screws where the service horsepower exceeds 5,200.

(*c*) An addition of 12 percent has been made to the calculated time in port, to allow for stoppages during holidays, week-ends, etc., and an allowance has been made for coaling during the 8,000-mile voyages. In addition to these, 14, 18, 22, 26, and 30 days respectively have been allowed for each size of vessel per annum for repairs and other delays, and these have been assessed at their rates per voyage. It has been assumed that coaling will be effected while the cargo is being worked.

(*d*) The coal per voyage has been estimated from a curve, the ordinates of which are 2 pounds per horsepower per hour at 800 horsepower, 1.7 pounds at 2,200 horsepower, and 1.6 pounds where the horsepower is 4,000 or more. The coal for port use has been assumed as proportional to the weight of cargo and the distance H. It was also assumed that vessels making an 8,000-mile voyage would be rebunkered at a port intermediate between the terminal ports.

(*e*) The net tonnage is that obtainable by Board of Trade regulations, and includes the present allowances for propelling space.

(*f*) The money values are not the present ones, but as they are comparatively correct between each size and speed of ship, and between initial cost of vessels and cost of transportation, they have no

influence on the results of the relative efficiencies. Notwithstanding this statement, however, the effect of increased labor and other rates has been investigated, and the results are given later.

(*g*) Line No. 20 in Table I gives the "tons carried"

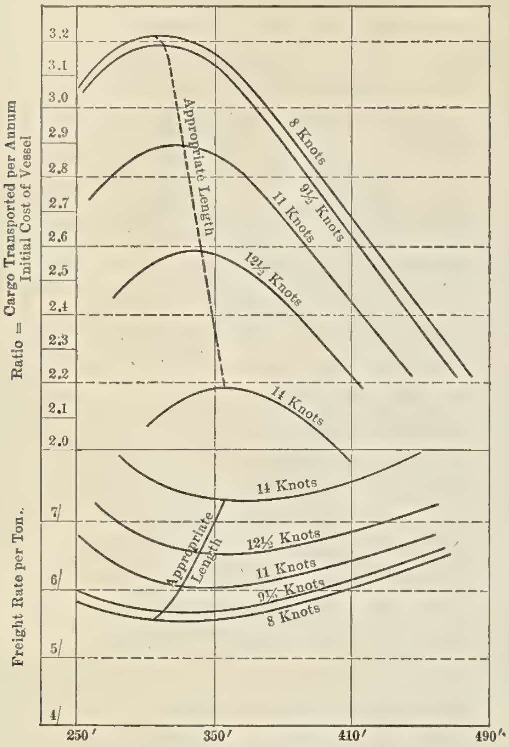


Fig. 7.—Scale of Length, 45 Percent Derrick Capacity, 1,000 Nautical Miles

in relation to the initial cost of vessel, and line 30 gives the estimated freight rates. Cross curves of these have been drawn for each stated condition, and Figs. 7 to 9 illustrate these curves for three of the conditions.

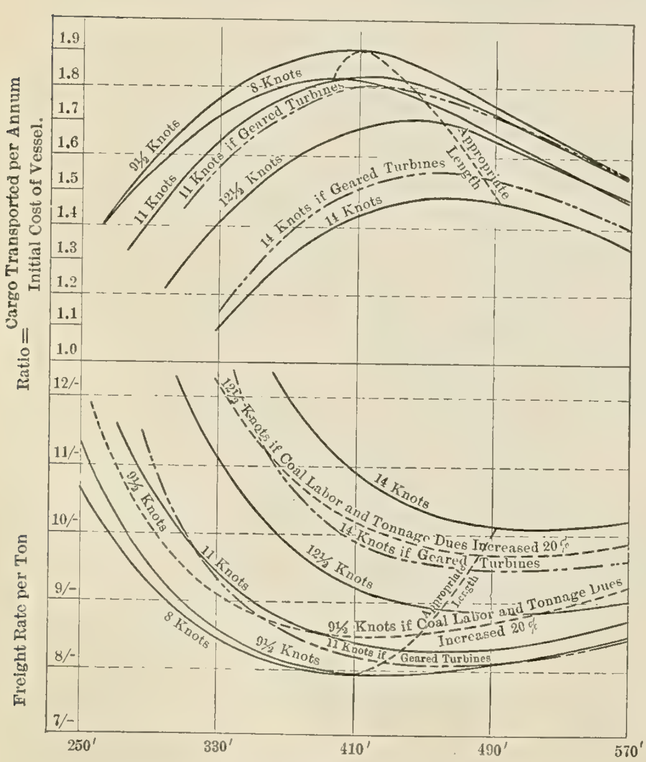


Fig. 8.—Scale of Length, Maximum Derrick Capacity, 4,000 Nautical Miles

RESULTS

It will be seen from these curves that the ratio of

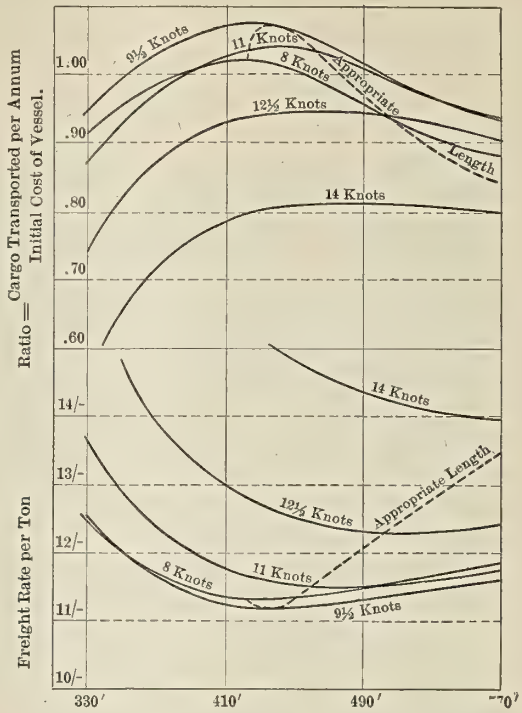


Fig. 9.—Scale of Length, Maximum Derrick Capacity, 8,000 Nautical Miles

"tons carried" defines the appropriate length most prominently; but as cost of coal, labor, etc., must also be considered, it was thought necessary to fix the appropriate

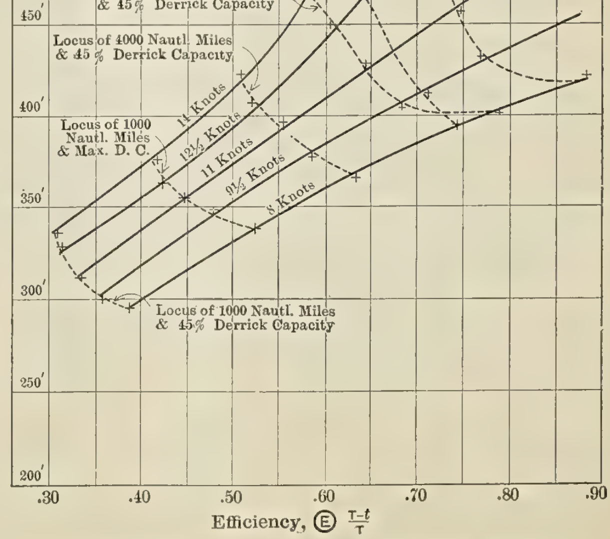


Fig. 10.—Appropriate Length in Terms of Efficiency

length line indicated, by interpolation, between the highest part of the "tons carried" curve and the lowest part of the "freight rate" curve.

To complete the main investigation, the appropriate lengths of each condition and distance have been plotted on a base efficiency E, and these results are indicated on Fig. 10.

The spots on this figure for the lengths appropriate to 8,000 miles and 45 percent derrick capacity are greater proportionately than those for 4,000 miles and maximum derrick capacity, the explanation of this difference being that the vessels on the longer voyage have intermediate coaling stations. The difference due to this fact does not, however, affect the results to any appreciable extent.

Figs. 7 and 9 represent the extreme limits of efficiency for the calculated conditions, their relation being $\frac{8,000}{1,000} \times \frac{1}{.45}$ = 17.8 times the loading speed, or length of voyage, and it is thought that from these and the curves on Fig. 10, lengths appropriate to best results for any known or average length of voyage, condition of loading or speed, can be obtained for vessels engaged in the carriage of cargo only and having no assistance from the revenue obtained by carriage of passengers.

To illustrate the effect of increased cost of coal, labor, and tonnage dues over the originally calculated amounts, additional lines have been indicated on Fig. 8 to show the effect of increasing the cost of these items by 20 percent, and it will be seen that although this would tend to increase the appropriate length such increase would not be of great magnitude.

Some calculations have been made to find the effect of vessels making return voyages in ballast trim, and it has been found that if the ballast run is estimated as an extended length of voyage, and not as lost time, in calculating the E value, a correct result will be obtained.

Fig. II gives the relative "tons carried" and "freight rate" in terms of speed for the appropriate lengths, and these have been plotted as a percentage of the best and lowest results. It will be seen that the most economical speeds are from 9 to 9½ knots, but it is understood that higher speeds are necessary when cargoes of a perishable nature are carried.

It has not been found convenient to illustrate the curves for each calculated condition of loading, but Table II is given to show the effect of altered discharging speed on the "tons carried" and "freight rate."

TABLE II.—TO SHOW THE EFFECT OF ALTERED DERRICK SPEED ON FREIGHT RATE AND TONS CARRIED AT THE APPROPRIATE LENGTHS.

Condition	Speed of Vessel	Derrick Speed	Freight Rate	Tons Carried
			s. d.	
1,000 nautical miles.........	9½ knots	Max. D.C.	4 9	4.89
	" "	45 percent "	5 8	3.19
" "	14 "	Max. "	5 9	3.49
	" "	45 percent. "	7 3½	2.18
4,000 nautical miles.........	9½ knots	Max. D.C.	7 11½	1.91
	" "	45 percent. "	9 2	1.50
" " "	14 "	Max. "	10 2	1.47
	" "	45 percent. "	12 7½	1.10
8,000 nautical miles.........	9½ knots	Max. D.C.	11 2	1.075
	" "	45 percent. "	12 6	.916
" " "	14 "	Max "	13 9	.82
	" "	45 percent. "	16 8	.687

Other Types and Proportions

The appropriate lengths shown on Fig. 10 will be applicable to other types of cargo vessels, provided that in comparing the dimensions of one vessel with another the characteristics and proportions are similar.

Stowage Capacity

Stowage capacity will often influence a designer in arriving at the most suitable size of a vessel, and it is found that the stowage rate per ton of cargo for fixed

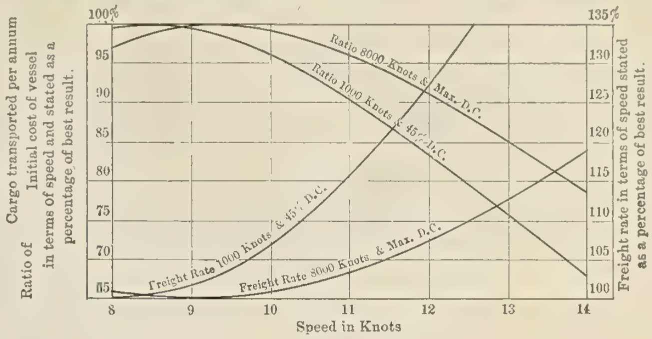


Fig. 11

speed is reduced as length is increased; it may, therefore, in some cases be found profitable to choose a slightly shorter vessel than the curves indicate.

Improved Types of Machinery

The effect of geared turbine installations with double reduction gears has also been investigated from the particulars given on Fig. 12 and the results are plotted for speeds of 11 and 14 knots on Fig. 8. It appears that these improved propulsive elements with reduced coal consumption would not appreciably alter the appropriate length of vessel. They affect the earning power considerably, however, and on account of the present relatively high

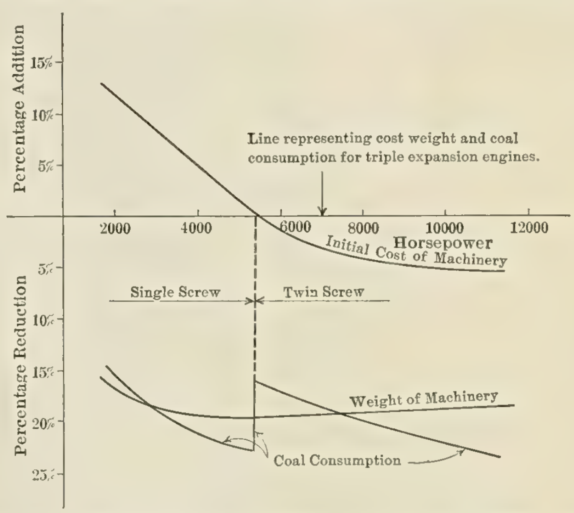


Fig. 12.—Diagram Showing Relative Values for Turbine Installations with Double Reduction Gearing in Comparison with Triple-Expansion Reciprocating Engines of Similar Power

initial cost of this type of engine for low powers, geared turbines are evidently unsuitable for speeds of less than about 10½ knots.

Conclusion

It appears from these investigations and the results of actual ships tabulated hereafter that the most suitable length of a "tramp" trader would be between 380 and 400 feet, with a speed of 9 to 9½ knots. The maximum efficiency E of the most up-to-date cargo liner does not exceed .60, which with a speed of 12½ knots would have a length of about 450 feet and a corresponding maximum draft of about 28 feet. In view of this maximum draft, it appears to be an open question whether the proposed deepening of trade routes should be considered prior to

legislation being completed for improvements in our harbors, such as increased berthing and loading facilities at quays, increased storage capacity, and the removal of many port restrictions which have caused detention to our ships in the past.

The curves of gross deadweight given on Fig. 13 will be found useful for comparing one vessel with another.

The writer desires to thank the directors of Messrs. Scotts' Shipbuilding and Engineering Company for their permission to publish these results. He also thanks the friends who have advised and assisted him in the development of these notes.

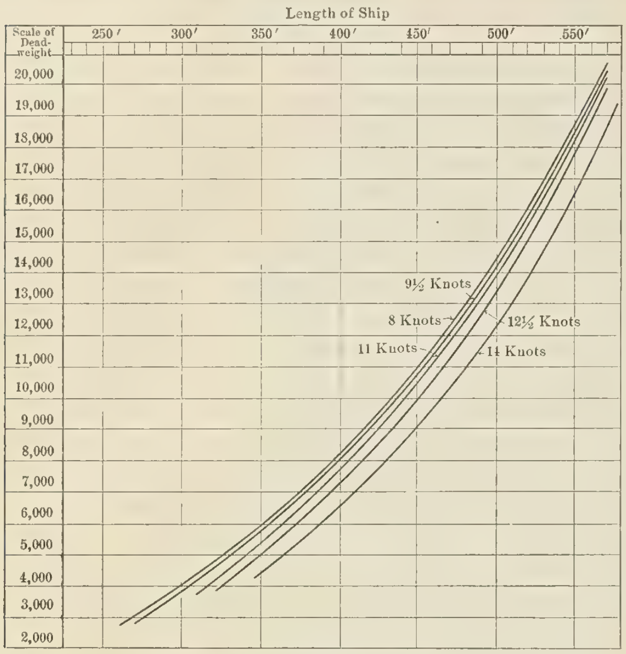


Fig. 13.—Gross Deadweight

APPENDIX

To show the possible use of, and the method of applying, the curves on Fig. 10 the following illustrations are given:

No. 1.—A cargo tramp, 400 feet in length, and having five hatches, each of which is worked by derricks at one end, has the following characteristics for the period under consideration:

Load deadweight	8,000 tons
Total steaming time	310 days
Total loading and discharging time	255 "
Total time for coaling, repairs, etc.	30 "
Average service speed	10¼ knots

Is this the most economical length?

The total period T is	=	595 days
The efficient period $T—t$ is	=	310 "
Giving an efficiency of E		.52 "

The length corresponding to E = .52 and a speed of 10¼ knots from Fig. 10 is 370 feet, but this reduced length is accompanied by a reduced deadweight, and, consequently, an increased efficiency. This variation in efficiency suggests that a length of 380 feet might be tried, and the particulars would then be—

Deadweight (from Fig. 13)		7,050 tons
Time on voyage		310 days
*Loading and discharging time $255 \times \frac{7{,}050}{8{,}000}$		225 "
Time for coaling and repairs		30 "
Total period T	=	565 "
Efficient period $T—t$	=	310 "
Giving an E value of		.548 "
The corresponding and final length would then be		377 ft.

The detail curves for the condition nearest to this vessel's efficiency show that if the vessel had been 23 feet shorter the "tons carried" would have been increased by 1 percent and the "freight rate" reduced by ½ percent.

* Estimated from the 400-foot ship in relation to the deadweight.

No. 2.—Proposed vessel for service between Bombay and Glasgow, or neighboring ports, a distance of 6,500 nautical miles. Speed on service 11 knots. Full cargoes can be obtained on all voyages, and it can be handled at an average of 150 tons per derrick system per day. Swinging derricks only to be arranged for, and the cargo can be handled over both sides of vessel at Eastern ports, but will be worked to and from a quay wall in Britain. The vessel will bunker before embarking and also at an intermediate port on each voyage. What is the most suitable length?

Try lengths of 360 feet, 400 feet, and 440 feet:

	Lengths					
		360 feet		400 feet		440 feet
		Tons		Tons		Tons
Gross deadweight per Fig. 13		5,750		7,750		9,900
Less coal for half voyage	530		620		710	
Less stores, fresh water, etc.	100		120		140	
		630		740		850
Net cargo to be handled		5,120		7,010		9,050
Number of derricks on each side		8		9		10
		Estimated time per trip				
		Days		Days		Days
Time to load at Bombay		4.27		5.20		6.03
Time to discharge at Glasgow		8.54		10.40		12.06
Time to coal on route		2.00		2.00		2.00
Time for shifts in harbor, etc., and all other delays		3.00		3.00		4.00
Total lost time		17.81		20.60		24.09
Total time at sea		24.60		24.60		24.60
Total time per trip		42.41		45.20		48.69
Efficiency (E)		.58		.545		.50
Lengths per Fig. 10 for these efficiencies		402 ft.		389 ft.		376 ft.

Column 2 gives the best agreement between the trial and the resulting lengths, and the most suitable length would be about 395 feet long.

No. 3.—Vessel 600 feet long engaged on a voyage of 5,000 nautical miles, and having a service speed of 12 knots. Thirteen derricks are arranged on each side, and these load or discharge from lighters on each side at each terminal port, each at the rate of 200 tons per day. Is this the most suitable length?

Gross deadweight (from Fig. 13)		23,500 tons
Less coal, stores, fresh water, etc.		1,900 "
Net cargo to be handled		21,600 "
Time required to load and discharge $\frac{21{,}600 \times 2}{26 \times 200}$		8.3 days
Time required for coaling and shifting		3.0 "
Average time lost for repairs, etc., per voyage		2.7 "
Total lost time per voyage		14.0 "
Total time sailing		17.4 "
Total time per trip		31.4 "
Efficiency (E) $\frac{17.4}{31.4}$	=	555
Length corresponding to this efficiency from Fig. 10	=	412 feet

It is evident that the efficiency will improve considerably with this reduced length, and on this account a length of 460 feet having ten winches each side might be tried. The particulars would then be—

Gross deadweight (Fig. 13)	10,700 tons
Less coal, stores, fresh water, etc.	1,200 "
Net cargo to be handled	9,500 "
Time required to load and discharge $\frac{9{,}500 \times 2}{20 \times 200}$	4.75 days
Time required for coaling and shifting	2.45 "
Average time lost for repairs, etc., per voyage	2.0 "
Total lost time per voyage	9.20 "
Total time sailing	17.4 "
Total time per trip	26.6 "
E value	.654 "
Corresponding length	460 ft.

This smaller vessel would transport 15 percent additional cargo in relation to the initial cost, and the freight rate would be reduced by about 4 percent.

TABLE III.—PARTICULARS OF THE WORKING QUALITIES OF CARGO SHIPS COMPARED WITH THE CALCULATED RESULTS GIVEN BY FIG. 10

No.	Trade Route	Approximate Length of Voyage	Length of Ship	Service Speed (Knots)	Total Time per Trip (Days)	Steaming Time (Days)	Corresponding E Value	Length from Curves, Fig. 10*	Remarks
			Feet		T	T—t		Feet	
1	Liverpool and United States	8,500	410	10.25	63	34.7	.55	390	Round voyage, outward in ballast, average of 4 voyages.
2	Liverpool and United States	11,000	365	10.60	82	47	.574	382	Round voyage, outward in ballast, average of 3 voyages.
3	Liverpool and Far East	25,000	390	10.70	149	99	.665	420	Average of 4 round voyages.
4	Liverpool and Pacific Coast	30,000	503	13.00	161	94	.585	460	Average of 4 round voyages.
5	Liverpool and Far East	25,000	452	13.80	128	71	.555	445	Result of 1 round voyage.
6	Leith to Far East	25,000	390	10.30	182	105	.575	388	Result of 2 round voyages.
7	British & Continental Coasting	1,500	215	8.0	16	7.1	.445	276	Result of 3 years' service.

* Corrected for change of efficiency due to change of length and number of derricks in terms of gross deadweight.

The writer is not aware of any existing vessels of the basis particulars in this latter case, but such a length, speed, and length of voyage has been suggested by Sir John Biles in his paper to the Institution in the year 1900.

Table III gives the actual working qualities of seven vessels, and indicates how their lengths as built compare with the calculated lengths.

Efficient Production at the Essington Works of Westinghouse Company

The Essington works at South Philadelphia, the huge plant of the Westinghouse Electric and Manufacturing Company built within the last year, is now in full operation, and all of its departments are running day and night as well as Sunday in completing one of the largest contracts for marine propelling machinery in this country. This order consists exclusively of apparatus for the United States government, and is a part of the enormous shipbuilding programme carried on by the Emergency Fleet Corporation.

The work under construction in the Essington factory covers the power equipment for three hundred and fifty ships. One hundred and fifty of these are for the Submarine Boat Corporation at Newark, N. J.; sixty for the Merchant Shipbuilding Corporation at Harriman, Pa., and Chester, Pa.; twenty for the United States Shipping Board; sixteen for the Chester Shipbuilding Company, and four for the Newburg Shipbuilding Company. The apparatus called for in this immense contract includes the complete installation on all these vessels of the Westinghouse marine power system, consisting of steam turbines, mechanical reduction gears, condensers, pumps with turbine drives, air separators, propeller shafting, stern tubes, bearings and other auxiliary steam apparatus. This system, which the Westinghouse Company has built for years at its East Pittsburgh plant, is the same as already largely installed in the United States Navy and in the Russian as well as in the Swedish marine service.

At the present moment the Essington works has actually under way in its foundry, machine and erection shops some seventy-five complete equipments. Of this number the foundry has finished its part for fifty turbines of the Submarine Boat Corporation contract, thirty sets of the reduction gears and forty-five of the condensers. This department has also completed the large castings for thirty turbines of the Merchant Shipbuilding Corporation order along with twenty-five of the reduction gears and twenty of the condensers. Besides this the foundry has well in hand all the auxiliary or smaller apparatus for the entire order.

The machine shops are working at present on the large parts for the forty-second Submarine Boat Corporation turbine, the fifteenth set of reduction gears and of condensers. They are also engaged on the tenth turbine equipment for the Merchant Shipbuilding Corporation order, along with the fifth set of reduction gears and the third set of condensers.

In the erection shops, where the finished parts of the apparatus are assembled, tested and then shipped, there are now under way in various stages of completion fifteen vessel equipments, which will be ready to leave the factory for their destination within the next thirty days.

While it was to have been expected that in a new works, where production was going on at the same time that building operations were under way and factory equipment was being installed, numerous difficulties and delays would be encountered, the works' organization is making wonderful progress, and the management has every confidence in finishing all the work on the original schedule dates.

At the present time the company has about four thousand operatives on its pay roll, consisting largely of high-class machinists and skilled mechanics. The plant, which is one of the largest in the Philadelphia industrial district, represents the most modern development in factory construction, its equipment in high-class machinery alone amounting to millions of dollars.

In accordance with arrangements made by the Westinghouse Company with the Emergency Fleet Corporation, there are now in course of construction near the Essington works two hundred houses for the accommodation of the employees. These are expected to be ready for occupancy by the first of October.

New Orleans Rushes Harbor Improvement Work

The harbor improvement project officially known as the Inner-Harbor-Navigation Canal of the Greater Port of New Orleans, which is being carried out with all possible speed by the Board of Commissioners of the Port of New Orleans, consists essentially of a navigable channel 30 feet deep, with a bottom width of 150 feet and a water level width of 330 feet, extending through the city of New Orleans a distance of nearly six miles from the Mississippi River to Lake Pontchartrain. At the Mississippi River end of the canal a 600-foot lock 75 feet wide and 30 feet deep will be provided to preserve the level of the water in the canal at the Lake level, which varies only a foot or two during the year, while the Mississippi River has a flood variation of nearly 20 feet at this point.

When the project is completed, New Orleans will have within the city a large inner harbor of practically fixed level, with marine terminals, industrial and storehouse sites accessible to rail, highway and ocean commerce.

Work on the project was begun on May 20, and plans call for its completion in eighteen months. The total cost is estimated at about $6,000,000 (£1,230,000). The project was designed and is being carried out under the direction of George W. Goethals & Company, consulting engineers, New York.

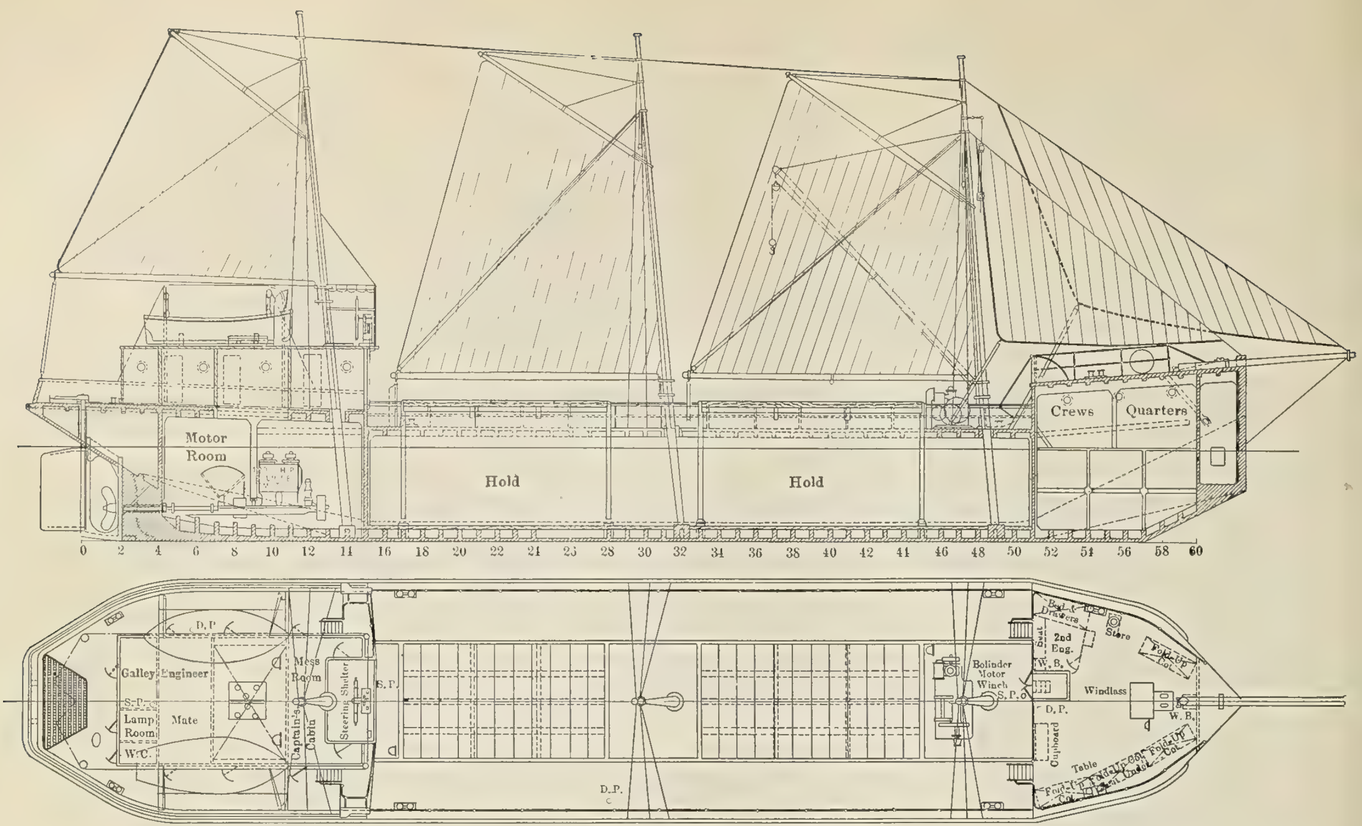


Fig. 1.—General Arrangement of Reinforced Concrete Motor Coaster, 125 Feet Long Between Perpendiculars, 25 Feet Beam and 11 Feet 9 Inches Molded Depth

Reinforced Concrete Vessels*

Discussion of Factors Involved in Designing Small Coastwise Concrete Motorship

BY WALTER POLLOCK

THE first reinforced concrete boat was a small rowing boat built and patented by M. Lambot, of Carces, France, in 1849. Apparently nothing further was done until 1887, when the sloop *De Zeemeuv* was built in Holland, and has been in constant service since, including work among ice, and is reported to be still in good condition. In 1896, C. Gabellini, of Rome, made a rowing boat by plastering cement and sand on both sides of a steel wire mesh, making a total thickness of 1 inch. In 1905 this same firm constructed the lighter *Liguria* and, following its seagoing trials, several other cargo vessels. It is stated that there are now in Italy vessels and pontoons which have been tested under severe loading to the satisfaction of Italian naval officers. In 1909 a barge or lighter carrying 220 tons was built in Frankfort-on-Main for the transport of gravel.

In 1910 a concrete scow was built in San Francisco 100 feet by 30 feet by 7 feet and of 525 tons carrying capacity. In 1911 concrete barges were built on the Panama Canal, 64 feet long by 24 feet wide, with a depth of 5 feet 6 inches. In the same year a barge was built by Mr. O. F. Lackey, of Baltimore, length 50 feet, breadth 22 feet, and depth 7 feet, carrying 86 tons of cargo. As a result of the experience with this barge, a concrete scow of 500 tons was built in 1912 by the First Concrete Scow Construction Company, of Baltimore.

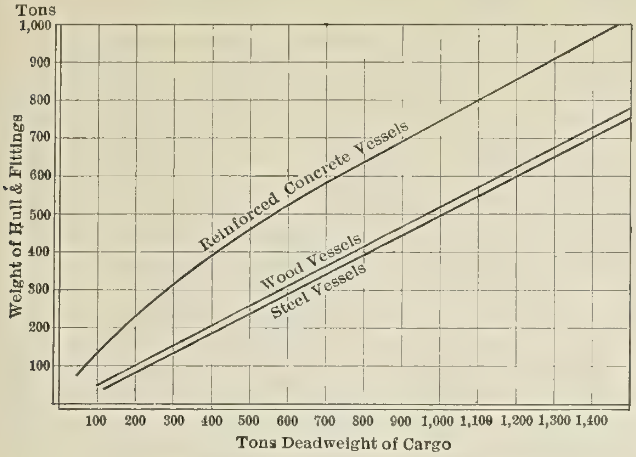
Among more recent constructions may be mentioned the *Namsenfjord,* a coaster of 200 tons deadweight built by the Fougner Company, of Norway, in 1917. The *Beton I,* another 200-ton vessel, was launched keel uppermost in August, 1917, by the Porsgrunds Company, Norway. A 5,000-ton deadweight capacity vessel is now being built in San Francisco, length 320 feet, breadth 45 feet, depth molded 31 feet, draft 24 feet, and is to be fitted with steam machinery of 1,750 horsepower.

For river and harbor lighters, tugs and coasting vessels, this form of construction will, if all the present experimental vessels are successful, probably remain a recognized form of construction for some years to come. Steel vessels may come back to their own as soon as freights are low and the competition keen. For larger vessels, up to, say, 2,000 tons deadweight capacity, reinforced concrete will no doubt prove a practical and commercial proposition for a few years.

Particulars are given above of a vessel of 5,000 tons being constructed in San Francisco, but it is difficult to see the advantage of using concrete in this case, as the amount of steel required for reinforcement, etc., will probably amount to 75 percent of that of a steel ship of the same deadweight capacity. The gain, together with the saving

* From a paper read before Institution of Naval Architects, London, March 22.

in skilled labor, seemed hardly sufficient to warrant the increased weight. It therefore seems probable that immediately the really critical situation as regards steel and skilled labor is passed, large vessels will no longer be constructed of concrete.



A.—Curve of Comparison of Weights

Designers and builders are striving to produce a reinforced concrete vessel:

(*a*) That will as nearly as possible reduce the weight of the hull to that of a steel ship of the same deadweight capacity.

(*b*) That will contain not more than one-quarter or one-fifth of the steel that is required in a steel ship.

(*c*) That will be sufficiently strong and safe with a thin concrete hull to stand stresses and ordinary knocks, and at the same time have the necessary density to ensure watertightness.

(*d*) With a concrete that will not fracture by expansion

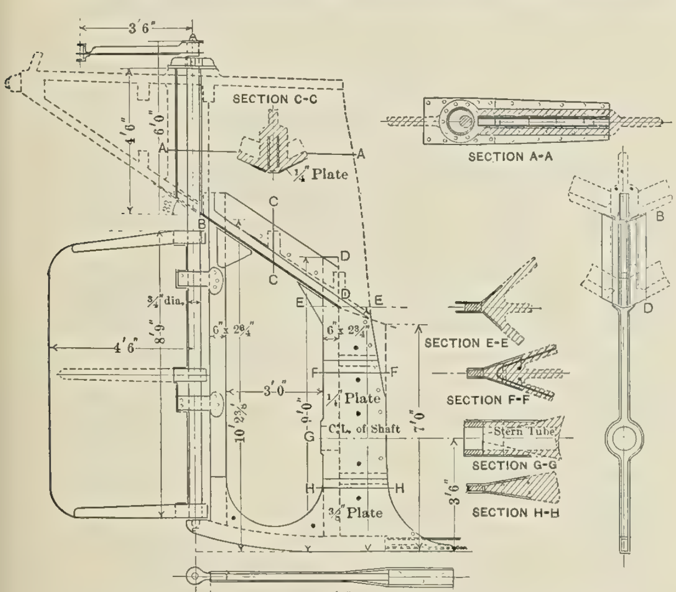


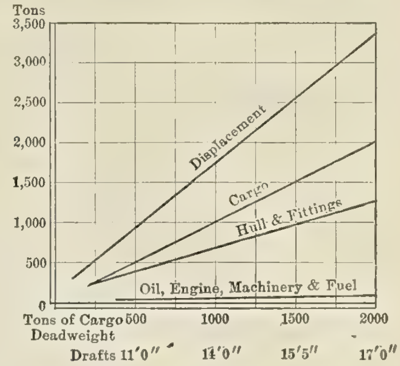
Fig. 2.—Patent Stern Frame for 125-Foot Reinforced Concrete Motor Coaster

and contraction, and that can be protected from disintegration in contact with acids, etc.

(*e*) That can be launched quickly after completion, without danger to the concrete work.

(*f*) That, after bottom and side damage has been repaired, can be put to work again quickly without waiting several weeks for the repair work to set and harden.

From the naval architect's point of view there are no great difficulties in the design and construction of concrete vessels. River vessels have to provide only for ordinary hydrostatic pressures, except where they have to ground on an even bottom, and the shocks and stresses due to coming in contact with other vessels, quay walls, etc. Seagoing



B.—Displacements, Weights and Cargo

vessels have to provide for dynamic forces due to mooring, berthing, docking, etc., as well as sagging, hogging and torsional strains when striking or falling in a heavy sea. The vibration of a ship in ballast after striking a wave may be found one of the most serious problems in concrete ships.

The bending and hogging strains due to wave conditions can be readily calculated, but the torsional and racking strains cannot. Shallow draft and river vessels, having as a rule only the strains due to unequal loading, grounding, etc., thus allow the scantlings to be lighter than is necessary for seagoing vessels.

The ideal design would appear to be a vessel with longitudinal construction (dispensing with two-thirds of the usual floors and frames), fitting only a few web-frames and as many bulkheads as possible, and in addition to the

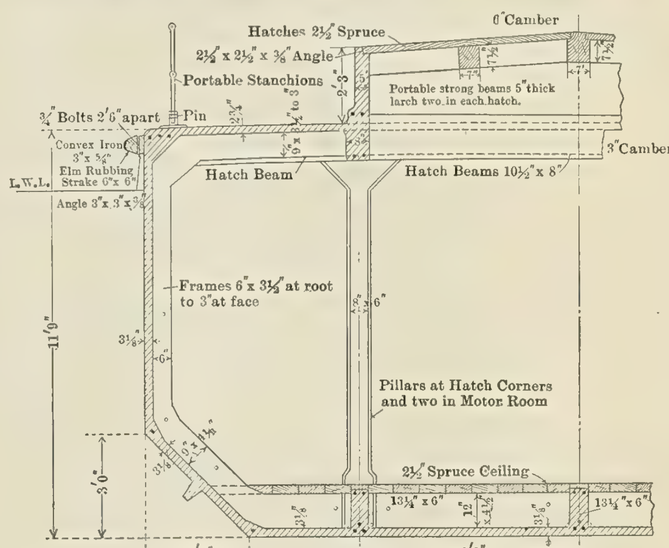


Fig. 3.—Midship Section of 125-Foot Reinforced Concrete Motor Coaster

usual longitudinal rods, a series of diagonal ones. In larger size vessels it would no doubt be advisable to fit a center bulkhead for the full length of the ship, but in any case it is advisable for cargo vessels to have the hatch coamings continuous all fore and aft, as shown in Fig. 1. In smaller vessels a continuous carling, even if it projects 6 inches above the deck, is desirable.

The calculations are in general similar to those of a

steel ship. A set of curves of bending moments and shearing forces for a 300-ton deadweight vessel are given in Figs. 4 and 5.

It is not difficult to design a reinforced concrete vessel with graceful form, nice curved lines and a handsome sheer, though difficulty and expense are involved in building and in keeping the steel reinforcements in place during molding and casting. To overcome these difficulties, the author designed the "straight-lined" vessels in July,

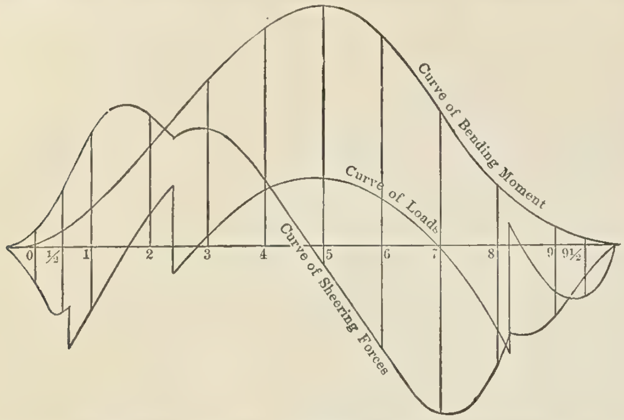


Fig. 4.—Crest of Wave. 1,300 Foot-Tons Maximum Bending Moment (Hogging)

1917, and published a number of designs wherein all the transverse sections are straight lines throughout the ship, the sheer being also in straight lines. The central portion of the ship for more than two-thirds of the length is rectangular, except for the angle of the bilge, which forms a double chine (see Fig. 3 and Fig. 7).

If the steel reinforcement is not kept in its proper position both vertically and horizontally in the thin slab walls of the shell, bulkheads, hatch coamings, bulwarks, casings, etc., a considerable amount of the strength of the reinforced concrete structure will be sacrificed. It is almost impossible to keep all the steelwork in its proper position,

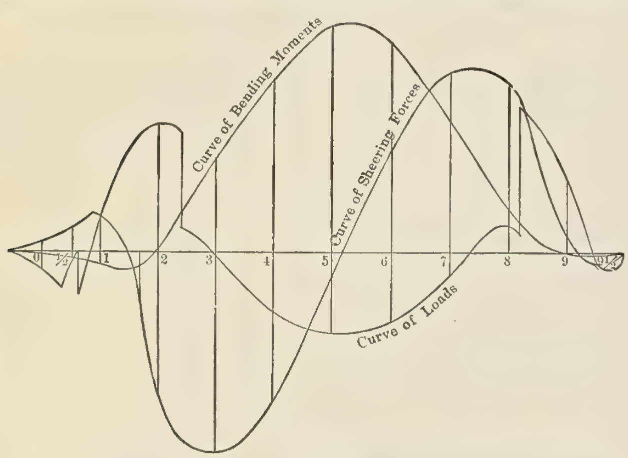


Fig. 5.—Hollow of Wave. 1,230 Foot-Tons Maximum Bending Moment (Sagging)

and a deviation of the bars one side may bring them so close to the surface as probably to throw off the concrete, or if set inwards to reduce considerably the strength of the slab locally. Furthermore, if the steel rods be not true to line, they tend to straighten out when subject to a tensile pull and cause the concrete to burst off, besides reducing their effectiveness by introducing secondary stresses.

The unit method of construction is being tried, but the advantages for ship work have yet to be proved, while the disadvantages are serious; so that the monolithic system, which makes it easy to obtain continuity of strength, is almost universally used.

For small vessels, barges, etc., a slab form of construction (Fig. 10) should be much more economical, as it dispenses entirely with floors and frames, side keelsons, stringers, beams, etc. The shuttering, being reduced to a minimum, is quickly placed in position and more rapid construction attained.

Bulwarks and hatch coamings are difficult to design for avoiding damage while loading or discharging cargo. The former can therefore be dispensed with and hinged stanchions and lifelines substituted, especially if the hatch coaming is made continuous. The latter should have a strong top and rest bar to avoid damage (see Fig. 9).

Fenders are necessary for all concrete vessels to protect the concrete, but in an experimental barge of 130 tons deadweight capacity fenders have been entirely dispensed with on the advice of the concrete designer, the corners of the gunwale being well rounded and finished off with a mortar of one of cement to one of sand, so as to avoid being chipped when coming in contact with or striking other barges. A solid half-round for the gunwale, as shown on Fig. 10, and other chafing irons, are desirable and may prove an advantage. It would be advisable to

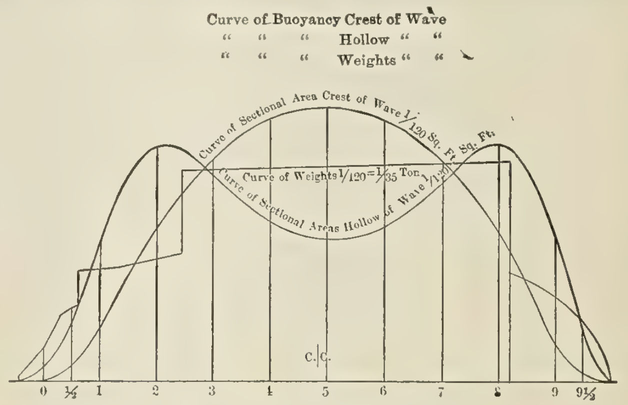


Fig. 6.—Curves of Buoyancy

fit fenders to all vessels as a precautionary measure, at least for the present, following the usual method of fitting close against the concrete work instead of a few inches off the shell with wood chocks in way of the bolts. A fender at the bilge, as shown on Fig. 9, will protect the concrete, and at the same time act as a bilge keel. All edges or corners throughout the vessel should be rounded or beveled where possible to prevent being chipped or broken off. If the concrete is subject to considerable rubbing or chafing, it will wear away.

There are the following methods of reinforcement:

(*a*) Wire netting, expanded metal, and similar meshwork with or without bars.

(*b*) Flat bars, special bars, steel joists, etc.

(*c*) Round bars of varying diameters.

All of these are suitable for either the unit method or the monolithic method of construction, and may be used either singly or in combination.

The wire netting and expanded metal is not likely to be adopted for the shellwork of seagoing vessels, because of the difficulty in keeping it true to line and obtaining homogeneity, as well as its excessive cost and the difficulty in varying the network sufficiently to suit the stresses.

Various sections other than round bars have been adopted in a number of cases, especially in America, but no doubt the round bars will be generally adopted, because they utilize the steel without waste, are easy to arrange

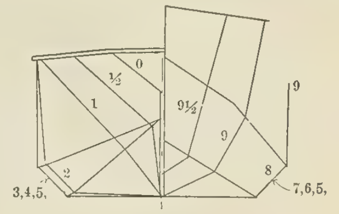
in position, easier to bend, more readily obtainable, and adapt themselves to a minimum quantity of concrete. Some claim that mechanical bars (to which kind all special bars belong) develop greater adhesion than round bars, but many reinforced concrete experts think the claim fallacious.

The larger steel bars are arranged longitudinally, generally in way of the deck line and the bottom of the ship, while there are also rods of nearly the same size arranged transversely, the whole being connected by small bars from 3/16 inch to ¼ inch, forming, say, a 6-inch mesh over the whole surface, making as far as possible a monolithic structure, a reduction in the number or total sectional area of the rods, both longitudinally and transversely, being arranged towards the ends of the vessel.

There are four methods of jointing the steel rods: (1) by a long overlap, (2) by a short overlap with hooked ends, (3) by welding, and (4) by turnbuckles or other mechanical attachment. The long overlap, which is usually 40 diameters of the rod, although some go as low as 20 diameters, relies entirely upon the adhesion or grip of the concrete to the bar. The short overlap of, say, 12 diameters in the small rods and 18 diameters in the rods over 1 inch diameter relies mostly upon the hooked ends and appears to be a satisfactory solution, as it reduces weight without sacrificing strength. Welding is certainly the most economical as regards weight, but if done in the shop makes the rods difficult to handle and keep in shape, and if in place may result in a local weakening of the rod at the weld. A mechanical connection, such as a turnbuckle, to unite screwed ends of the rods, is sometimes adopted for special purposes. The cost of welding and mechanical connection is usually considered prohibitive. In each of the above cases the loss due to the weakness of all riveted seams or butts in a steel ship is avoided.

In order to resist the diagonal tensile stresses induced in a beam by the action of the shearing force, stirrups are frequently introduced extending between the tension and compression members. They may be considered as the web members of a truss system, the triangulation of which will vary as they are placed vertically or diagonally.

While there is a well-defined theoretical method employed by designers of reinforced concrete structures for the determination of the sections, the calculations depend upon the use of coefficients determined from experiments which have all been made upon concrete under the condi-



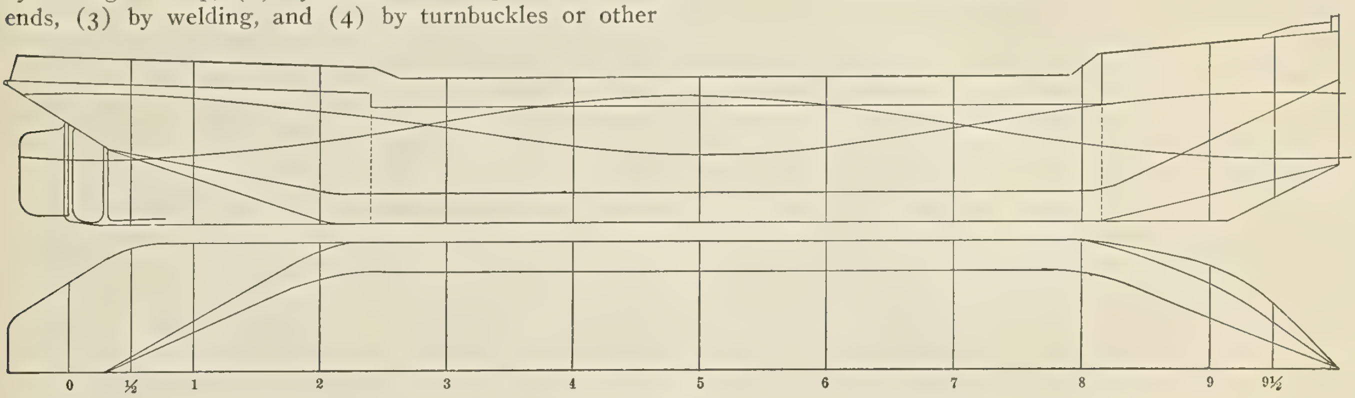


Fig. 7.—Lines of Modified Type of Reinforced Concrete Coaster

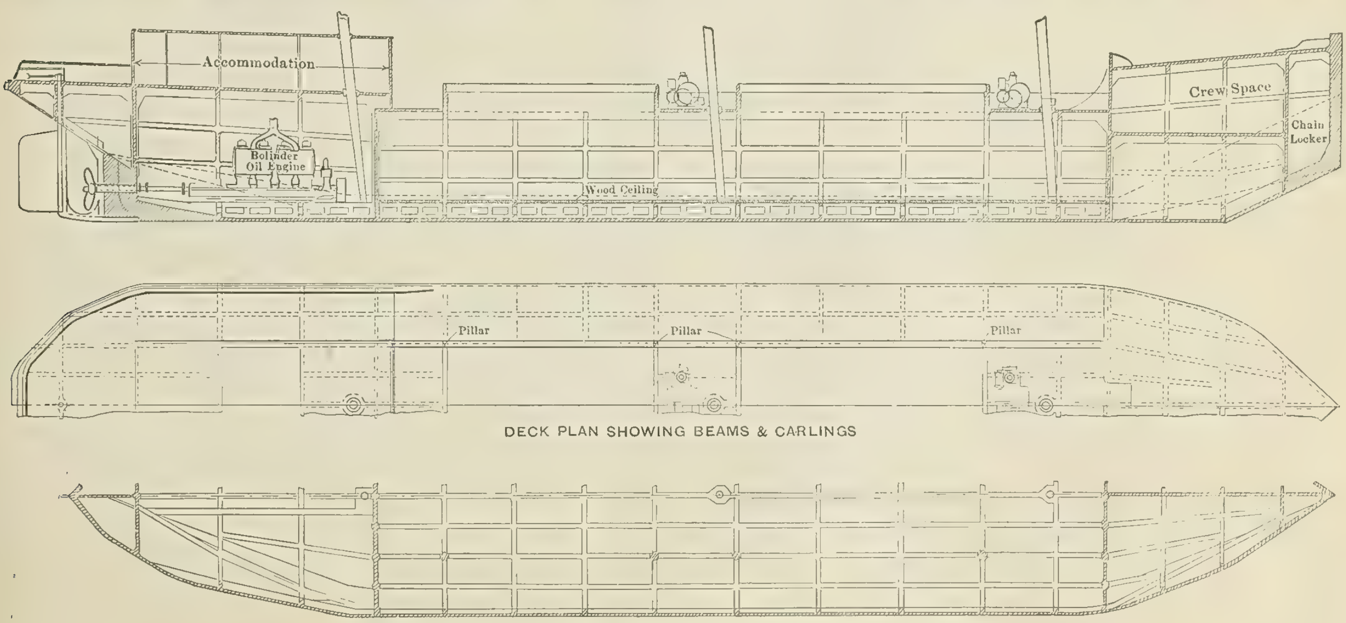


Fig. 8.—General Arrangement of 500-Ton Reinforced Concrete Coaster. Length Between Perpendiculars, 155 Feet; Beam, 29 Feet 6 Inches; Depth, Molded, 13 Feet 3 Inches

tions in which it is employed in buildings, and consequently the experimental data for shipbuilding work have yet to be derived. For this reason the paper leaves out consideration of the usual practice in allowable stresses which might, if included, lend color to the supposition that calculations could be made quite definitely on the present experience.

For deriving the equations for determining the properties of reinforced concrete sections, it is necessary to know

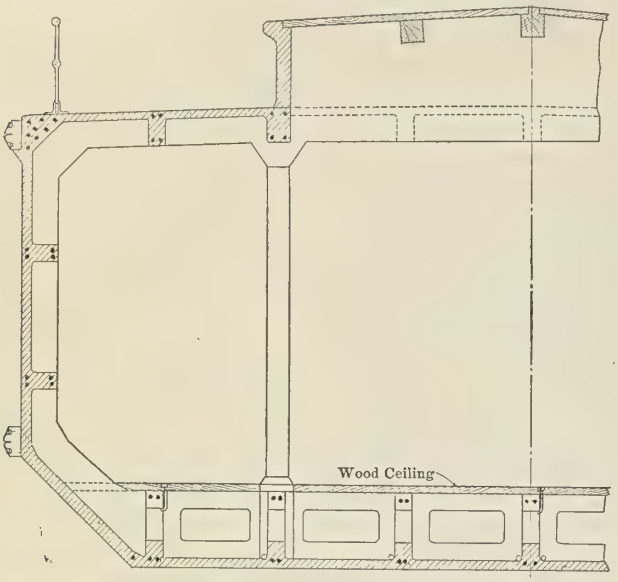


Fig. 9.—Midship Section of 500-Ton Reinforced Concrete Coaster

the moduli of elasticity for concrete and steel and the ratio as used in combination, because, while the modulus of steel is fairly constant up to the yield-point and is well known, the moduli of concrete vary with the quality of the concrete and the stress upon it, the modulus being greatly reduced as the stress increases. Therefore, in a reinforced concrete beam the ratio of the moduli of elasticity that is used for determining the position of the neutral axis and the other properties of a section is not the ratio that exists between the initial moduli of elasticity of the two materials. As the modulus of the concrete would vary to some extent with the constant or intermittent immersion of water, it is evident that the ordinary modular ratio of 1 to 15 that is used for structures may not be at all appropriate, having regard to the richer mixture of concrete employed and the greater factor of safety previously advocated.

The resistance of concrete to tension is generally neglected and it seems desirable to neglect it in ship design, but attention should be given to the fact that concrete is comparatively weak in tension, and therefore may be rather unsound for some part of the full thickness of the section, and consequently the watertightness depends on a section of less thickness.

It seems advisable at the present time to employ a factor of safety of 6 as regards the crushing strength derived from experiments on concrete blocks made in the ordinary way and allowed to dry out in the air, such crushing strength being that obtainable at three months. It will be found advantageous to employ concrete richer in cement than that ordinarily used for buildings, and made with ballast or other coarse material (sometimes called aggregate) restricted in size. There is also another element in question, as to what reduction in stress, if any, should be allowed in concrete which is always kept in water and that which is alternately wet and dry, while it is necessary in addition to ascertain what effect salt water has on the strength of concrete used in a vessel, although data go to show that salt water has no effect on a dense concrete.

The weight of reinforced concrete hulls is the most serious problem in the adoption of this type of vessel, the concrete being 143 pounds per cubic foot, plus the reinforcement. The bare hull with fittings of a coasting vessel of, say, 300 tons deadweight will weigh 130 percent more than that of a steel vessel, while the increase in total displacement is about 40 percent (see table below). Put in another way, if a concrete coaster was built of the dimensions and coefficient of fineness of a 420-ton deadweight steel vessel, it would only carry 300 tons deadweight on the draft.

The linear increase (length, breadth and depth) would be 12 percent to 14 percent greater for a concrete vessel than for a steel vessel.

The figures in the table of the 300-ton concrete vessels are based on the ordinary method of construction as shown in Fig. 1, and not the author's improved method of construction shown in Fig. 8. The practice of stating that a concrete hull is from 50 percent to 70 percent heavier than a steel vessel of the same dimensions does not give a fair comparison, because the concrete hull would carry much less cargo. The method of comparing the weights to vessels of similar deadweight has therefore been adopted.

It will be seen that the total steel is only 27 percent, the reinforcement alone accounting for 25 percent of that of a steel vessel of the same deadweight capacity.

The weight of the bare hull of the 500-ton vessel, illustrated by Figs. 8 and 9, is only 400 tons, which shows a reduction of 15 percent as compared with the figures of the 300-ton concrete vessel.

A 1,000-ton deadweight towing lighter would weigh about 90 percent to 100 percent more, the displacement being about 25 percent more, and the linear increase 7 percent more than that of a steel lighter of the same deadweight. The percentage difference in weight gradually decreases up to, say, 2,500 tons deadweight.

COMPARISON OF A 300-TON DEADWEIGHT VESSEL IN CONCRETE, WOOD AND STEEL

	Reinforced Concrete	Wood	Steel
Length	125′ 0″	108′ 0″	105′ 0″
Breadth	25′ 0″	23′ 9″	21′ 0″
Depth	11′ 9″	10′ 7″	11′ 4″
Draft bottom of keel aft	10′ 3″ (no keel)	10′ 3″ (keel)	10′ 3″ (no keel)
Deadweight cargo, tons	300	300	300
Cubic capacity of holds and hatchways, cubic feet	17,320	12,350	12,500
Displacement, tons	640	495	455
Time to construct, months	4	8	6
Weight of steel, tons	28½	15	110
Weight of bare hull, tons	290	140	120

The best concrete is the concrete that is the densest; the principal consideration is its permeability. To obtain the necessary density, the cement must be finely ground, the aggregate carefully graded and not too coarse, and the mixing thorough. If the concrete is too rich it is subject to greater contraction and cracks. It is made of cement, sand and aggregate, and for ship work the proportions are usually of 1 to 1½ to 1½ by weight, although the author prefers to specify a mixture of 1 to 3 graded ¼ inch downwards.

The cement usually obtainable is to the British Standard Specification, which provides for a residue on a sieve 180 $\times$ 180 = 32,400 meshes per square inch, not exceeding 14 percent.

The steel for the rods is usually of shipyard quality of mild steel 28 to 32 tons per square inch tensile, although

some reinforced concrete experts prefer medium carbon steel (to which category shell discard steel belongs) with 35 to 45 tons per square inch tensile, a contraction of area at fracture not less than 45 percent, to withstand bending cold to 180 degrees, around a diameter equal to twice that of the bar without fracturing the skin of the bent portion.

A minimum covering of the reinforced steelwork with concrete is desirable so as to reduce the weight of the structure, while, at the same time, it must be sufficiently strong to prevent the concrete from breaking away under the torsional and other stresses that a vessel is subject to. For the slab work it will be found necessary to have at least a covering of 1½ inches of concrete over all the bars, floors, frames and keelsons, and where heavy bars are used it is advisable to have a covering of not less than 1 inch of concrete, and even 1¼ inches may be necessary.

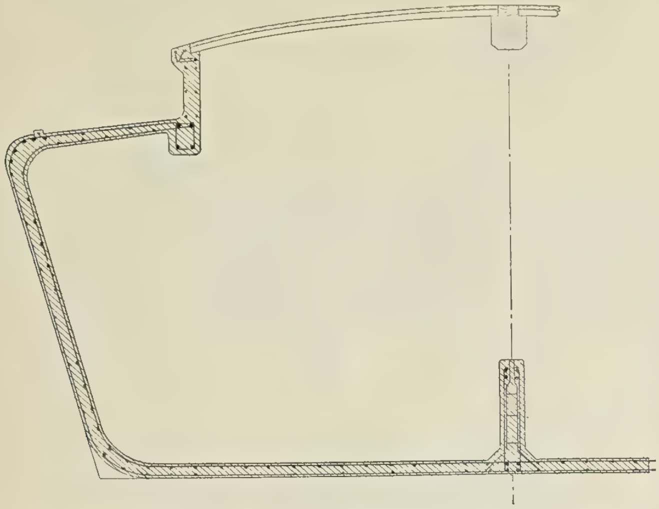


Fig. 10.—Midship Section of Reinforced Concrete Swim Barge (Wells System)

The deck may have a granite finish composed of ¼-inch washed granite and cement gaged 2½ to 1, laid at the same time as the under concrete and sprinkled with fine carborundum before the casting is finished. The latest vessels being constructed by the author are having a chequer pattern cast in the finishing coat.

For a 300-ton vessel a 3-inch shell or slabwork will be found sufficient for a 500-tonner 3½ inches, and for a 1,000-tonner 4 inches.

It will be noticed that in Fig. 9 it is proposed to fill a fillet of reinforced concrete under the wooden fender; this fillet could be arranged locally, say 10 feet apart, or continuously all round the vessel in way of the fender, which would enable the construction of an external side stringer to be formed, the inside stringer being consequently reduced.

The section and longitudinal elevation of the 500-ton auxiliary coaster introduce several new features. The vessel having a length between perpendiculars of 155 feet, breadth 29 feet 6 inches, and a depth molded of 13 feet 3 inches is designed on the longitudinal principle, the frames being spaced 8 feet apart. The hold ceiling would be fitted transversely in a vessel of this type, the frames and keelsons being hollowed to reduce weight, and the inside curvature of the shell slabs or panels facilitating the use of light steel shuttering.

The stern frame requires special consideration and design to ensure proper attachment to the reinforced concrete work, especially where a stern tube is fitted. Fig. 2 illustrates the author's patent stern frame, the construction in several pieces being really a war measure and designed to reduce the amount of forged work to a minimum. It will be noticed that the reinforced rods are well connected to the plates and angles. At present it is hardly worth while to make the rudders of concrete, although this is quite possible for large ships; the same remarks apply to masts.

At present the shuttering is of wood; planed, tongued and grooved boards are desirable to obtain a neat fair surface or finish of the concrete work. For a large number of vessels of the same type it would probably be more economical, even at the present time, to use cast iron shuttering. Pressed steel shuttering would have advantages. Then, again, there is a possibility of reinforced concrete shuttering being used.

The prime cost of the finished reinforced concrete work for an ordinary vessel with ship-shaped lines at the present time should average $42 (8/15/0) per ton, made up with the double shuttering at $4.33 (0/18/0) per square yard for timber, and $1.55 (0/6/6) for labor; the concrete at $0.40 (0/1/8) per cubic foot, and the round steel bars from $79 (16/10/0) per ton for the large diameter to $108 (22/10/0) per ton for the small diameters. Vessels with straight lines will cost less, and probably a saving of $4.80 (1/0/0) to $6.00 (1/5/0) per ton will be made, the usual establishment charges and profit being added. These figures are based on a 300-ton deadweight coaster, and for the first vessel only. Larger vessels would, of course, show a reduction.

Taking the hull complete and comparing with steel and wood construction, even if the steel is obtainable at $56.50 (11/15/0) per ton, concrete vessels of the same deadweight should, if standardized, be constructed at 20 percent less cost than a steel vessel and 10 percent less cost than a wooden vessel. The machinery for propulsion will, of course, cost more because of the extra displacement.

With regard to the time for construction after, say, three building berths have been prepared: with ample labor available, and after the first vessel has been cast, the one set of shuttering, so long as it lasts, should enable a barge of 130 tons deadweight to be completed and launched every ten weeks, a 300-ton deadweight coaster every sixteen weeks, and a 1,000-ton deadweight coaster every twenty weeks.

Method of Concrete Ship Construction

BY THEODORE AHLBORN

VARIOUS ships and barges have been built of concrete and steel, the ratio of concrete to steel varying with the different designs. This, of course, is natural, as reinforced concrete is a material only recently adopted for more extensive use in shipbuilding and the effect of the action of high seas on concrete ships is, to a large extent, not well enough known, and practical experience is absolutely needed to determine the weak points in such ships, as stresses will occur which up to the present time could not be determined even in steel or wooden vessels.

In order to produce a design which will take care of any and all stresses known up to the present time, and some which are not known, the writer was guided by the following assumptions:

(1) All steel to be protected by a cover of concrete in no case less than ¾ inch thick.

(2) Structural section, if used at all, to have flat surfaces not more than 2½ inches wide, except main keel, which may have sections having flat surfaces not over 4½ inches wide.

(3) Safe allowable stresses to be used are:
Steel, 15,000 pounds per square inch in tension.
Steel, 7,500 pounds per square inch in shear.
Concrete, 750 pounds per square inch in bending compression.
Concrete, 75 pounds per square inch in shear.

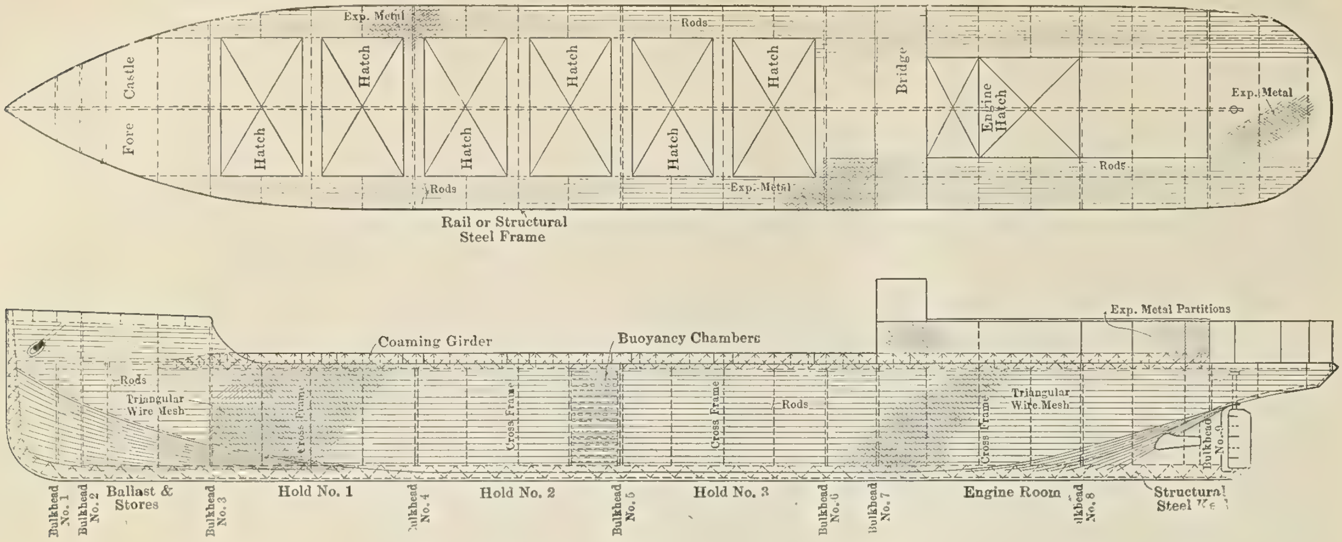


Fig. 1.—Typical Reinforcing for Concrete Ship

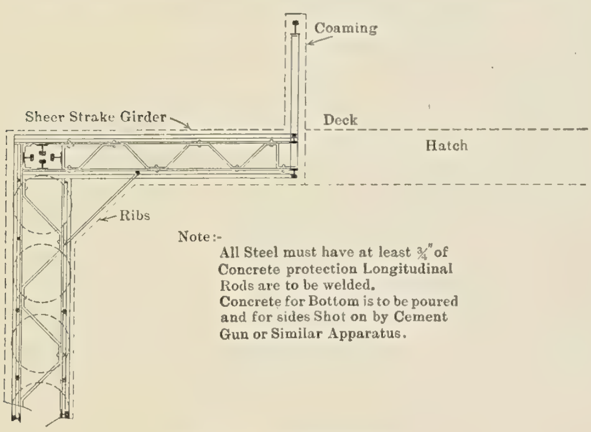


Fig. 2.—Hatch Section

(4) The ship's strength is to be calculated for hogging as well as sagging, and the moment WL-35 is to be used for ocean going vessels, WL-40 for lake vessels, and WL-

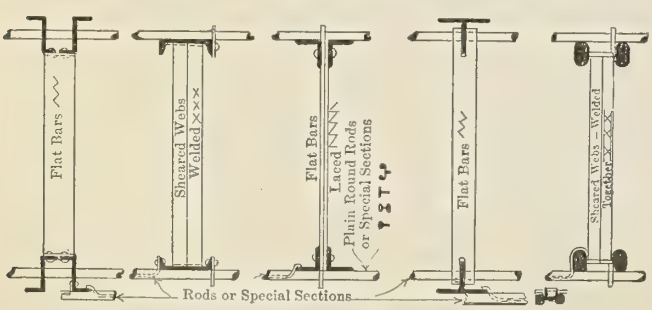


Fig. 3.—Main and Bilge Keel Sections

45 for river and canal vessels; the length of the beam equals the distance between perpendiculars.

(5) All concrete material must be absolutely clean and devoid of vegetable matters, and the sizes should not exceed ⅜ inch in its largest dimension. The cement must be of the highest grade and must pass A. S. T. M. tests. The steel rods are to be welded where possible and plain round rods are preferred.

(6) In sections where there is a doubt that the concrete can take care of the possible shearing stresses, the concrete is neglected in figuring and only the steel is called upon to resist the stresses.

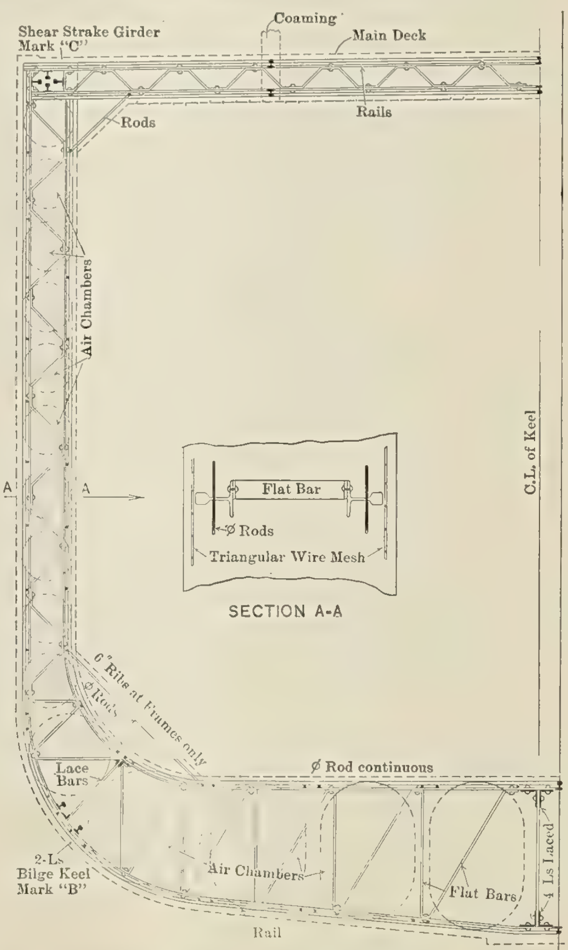


Fig 4.—Midship Section, Showing Reinforcing of Frame

The section amidships is taken as the most important one under consideration and consists of a keel built up out of either angles and bars or rails and bars and is illustrated in Fig. 4. The spaces between sections not less

than ¾ inch wide will permit the concrete to flow freely around the steel, preventing dangerous air pockets. Connecting to this keel are also rail frames spaced from 10 to 12 feet apart. These frames are held in position by bilge keels similar to the main keel and at the sheer strake by a girder section also built up from rails and laced with rods or flat bars. The construction of the bilge keel is shown in Fig. 3 and the sheer strake girder in Fig. 6.

The bottom of the boat is cast between sheet metal forms of No. 30 gage metal, left in place, forming hollow spaces which are used in carrying water ballast, or fuel

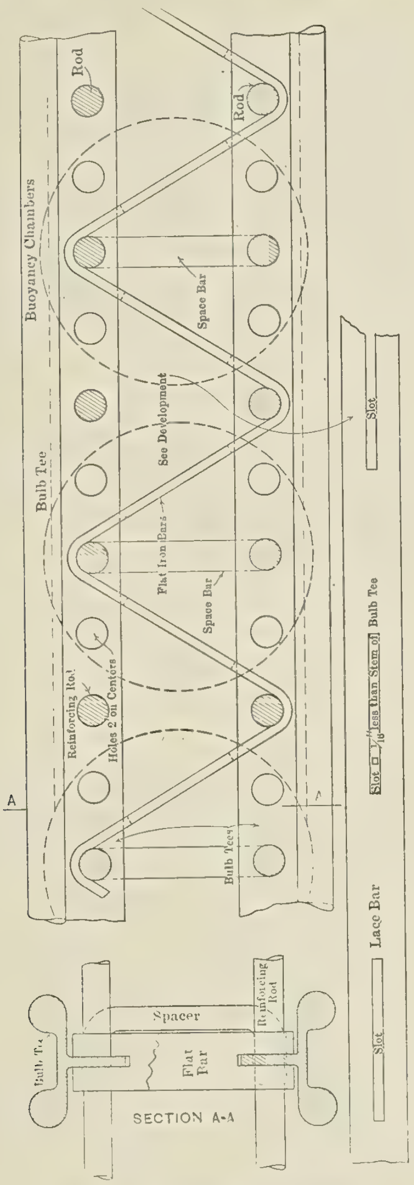


Fig. 5.—Typical Ship Frame Reinforcement

oil, etc. These spaces, called buoyancy chambers, are between transverse bulkheads, spaced from 30 to 40 feet apart, and are connected with the pumps to permit emptying and filling. The sections between the sheet metal forms are T-shaped, a very efficient design using the least amount of material for a given strength. This system is used throughout where possible, with the exception of the decks and bulkheads, which are solid.

Fig. 2 illustrating the hatches shows the coaming used as a section resisting tensional as well as compressional strains and therefore adding considerable strength to the whole design. The sides of the vessel formed by circular buoyancy chambers in the concrete again present a typical T-beam design reinforced with steel in both top and bottom flange. The sides, like the bottom of the vessel, can be designed either as a beam between frames as above mentioned, about 10 or 12 feet apart, or as a beam supported by the bilge keel on one end and the sheer strake girder on the other side.

The way the buoyancy chambers are most efficiently employed is dependent on the depth, load and length of the respective vessels. For long, deep vessels it is more profitable to run all buoyancy chambers in the stem to stern, but in shallow vessels it may prove more economical to run the side chambers from bilge to bilge. Each particular case must be determined separately.

If the hatches are more than 12 feet wide, the frames will be spaced so that there is a complete ring at every second frame; the frame between, being only part of a ring, will stop at the coaming of the hatches. In the latter case the coaming is reinforced to take up the extra strain resulting from the absence of the frame. All bulwark and deck bulkheads, pilot house, galley, crew's quarters, etc., are to be formed by either herringbone or other metal lath, with concrete mortar, either shot or troweled in place.

Methods of Construction

Forms.—After the ways have been laid down (it is assumed that the vessel is to be launched sideways) and the sliding ways are put in place on the standing ways using the proper lubricant (stearine and tallow), the

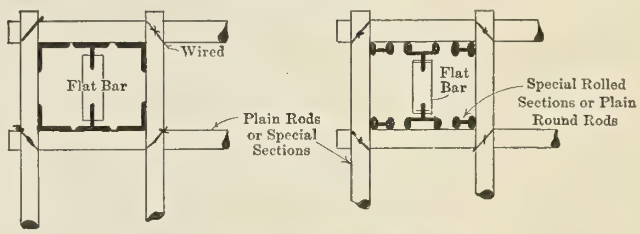


Fig. 6.—Sheer Strake Girder

lubricant is held in place by steel plates to be removed before launching. The forms of the bottom of the ship are now constructed on these ways. Care must be exercised that the keel will receive proper bearings on piles and blocks, using oak wedges, easily removable, but capable of bearing the weight it is necessary for them to support. All these forms must be absolutely watertight and must be so constructed that in no case sagging can occur. Use 4-inch by 4-inch or 6-inch by 6-inch posts on oak wedges placed at proper distances.

Steel.—The forms for the bottom now being in place the erection of the steel is the next step, starting with the keel. The frames, 10 to 12 feet apart, are next to be put in place from the bilge keels, then the sheer strake girder and, last, the balance of the structural steel sections as called for in the plans. The complete skeleton of structural steel being properly riveted together and lined and leveled up, is now ready to receive the bottom re-enforcing, running from to frame, then the sheet metal buoyancy chambers, and on top of this, again, re-enforcing rods running from frame to frame.

Following this the transverse bulkheads are re-enforced, first on one side from frame to frame, then the buoyancy chambers are put in place, and, finally, the re-enforcing for the other side. The same process is adhered to in re-enforcing the sides. The last re-enforcing applied is figured to resist shearing and is run from bilge to sheer

strake girder at an angle of approximately 45 degrees on both sides of the buoyancy chambers of the side walls; and if a center bulkhead is used, on both sides of the chambers of this bulkhead also. The remaining steel re-enforcing of the hatch coaming, main deck, etc., forming an integral part of the main hull construction is now put in place; after this is done, no other steel will be erected for the deck houses, bridge, etc., until the ship has been launched.

Concrete.—The concrete for the bottom is to be poured in a continuous operation and enough men must be employed properly to tamp and agitate the concrete so that it will receive its maximum density. This being done the operation of "shooting" the bulkheads with the cement gun should be started, at the same time commencing at the stem and operating two guns on each side of the ship, or six guns altogether.

A continuous process of "shooting" is preferable until the hull, with the exception of the deck, has been completed. The surfaces should be troweled smooth and glass hard by experienced cement finishers. Three days after the "shooting" has started the carpenters may begin to place such forms as are necessary to support the main deck. The re-enforcing being in place the concrete can then be started, using the pouring method as soon as sufficient space is available. It is most important that all sleeves, inserts, fittings, bolts, pipes, hawse pipes, bollards, etc., are in place before concreting is started.

All outside forms are to be removed before launching. The hull should be carefully inspected, on both sides and bottom, and if places are noticed where, because of leaking of forms, or for other causes, rough places occur, these are to be washed out with clean water and then a very good mixture of cement and sand must be shot in place and troweled hard so that the entire hull with have a neat, smooth surface. This being completed the dog shores holding the sliding ways are put in shape. The steel plates under the sliding ways are then removed, so that the ship is resting on the greased ways proper and is ready for launching.

The lower ends of the sliding ways are also greased preparatory to letting the ship down on the sliding ways in its cradle, with only two dog shores holding it. The temporary struts holding the shores in place can now be removed. The dogs are knocked out simultaneously by means of suspended weights held by triggers connected by a cord to be cut with a knife.

All points being observed the vessel should be launched in about twenty seconds.

Developments in Concrete Barges and Ships*

Brief Resume of History of Concrete Shipbuilding—What Has Been Accomplished in the United States and Abroad

BY J. E. FREEMAN†

IT has generally been considered that the earliest use of what is to-day known as reinforced concrete was the concrete garden tubs constructed by Monier in the 1850's. But it is a fact that an earlier development in boat building by the use of cement mortar on a framework of rods or mesh was utilized by M. Lambot in 1849 in building his historic craft, the first concrete boat of which we have record. This boat was exhibited at a World's Fair in Paris in 1855 and was still seen in successful use as late as 1903.

This general method of cement plaster construction developed further in Holland, when a small sloop, the *Zeemew*, was constructed in 1887, to be followed in more recent days by barges of 50 or 60 tons capacity, many of the open hull type which are used on the Dutch canals for handling sand and gravel or disposing of ashes and other refuse. The *Zeemew* was reported last year in the possession of a ferro-concrete company at Amsterdam, still in good condition despite the fact that it had been in quite a number of collisions and had repeatedly been hauled up a stone embankment and frozen fast every winter. One writer says it has been used many years for duck hunting in small bays, etc.

A recent article on the Holland work in Concrete and Constructional Engineering (London) contains this interesting statement—"Careful examination of two concrete boats which had been in regular use for seven and eight years, respectively, showed that no growths occur, if the surface of the concrete is smoothed before launching. If the surface is left very rough, barnacles or algae may adhere to it. The smoothly finished concrete also reduces the skin friction of the vessel when moving through the water....."

A concrete pontoon serving as a landing stage for ferry-boats at Sydney, N. S. W., has seen severe service since 1914. During the discussion following a paper on concrete ships at a meeting of the Engineering Association of New South Wales last July, some interesting information regarding this pontoon was given by an engineer evidently connected with the Harbor Board, who said: "It measures 110 feet in length, 60 feet in width at one end and 70 feet at the other, the depth being 7 feet 9 inches. It has about 3 feet 6 inches of freeboard and displaces 783 tons. It is divided into 44 watertight compartments, firstly, to provide against the liability to be sunk by collision and, secondly, to stiffen it to withstand the continual shock of the ferry-boats when berthing. The sides, bottom and deck are 5 inches thick and doubly reinforced; the bulkheads are four inches thick, and also doubly reinforced.

"This being the first of its kind built here and one of the largest afloat at the time anywhere, no risks were taken, and it is perhaps stronger than future experience may warrant. It is not a ship; it has to stand more severe usage than a ship would ordinarily experience, owing to the severe shocks often given by large ferry boats, which continue day after day to bump it while berthing."

We are all more or less familiar with the Italian barges built by Carlo Gabellini, among the early examples of which was the *Liguria*. Many concrete pontoons from the Gabellini yards have been built for bridges across the Po and other Italian rivers, and have required little maintenance though subjected to shocks from both ves-

* Paper read before the American Concrete Institute, Atlantic City, June 29.

† Portland Cement Association, Chicago, Ill.

sels and ice. Doubtless this same yard had much to do with the construction of the concrete barges that are now being used by our Italian Allies for mounting naval guns of large caliber used in the defense of the Piave river line. Here is certainly good evidence of the strength of concrete under heavy shocks and vibration.

Our own country possesses to-day an interesting example of the Gabellini type of barge. In 1912, a group of men in Mobile built a barge about 90 feet long, 26 feet wide and 9 feet deep, bringing over from Italy several engineers to supervise the construction. Doubtless owing to unfamiliarity of the owners with boat building and of the engineers with American conditions, this first craft was rather expensive and discouraged further operations, the barge remaining the sole example of their work. The barge was used for several years in handling coal, sand, etc., on the river, until driven ashore in a severe storm late in 1916, at which time a hole was punched in the side by a projecting pile or some such obstruction. Early this year the barge was repaired at small cost and turned over to a shipbuilding company at Pascagoula, Miss. The barge, though originally handling a deck load mostly, has now been carrying fuel oil in the hold—good evidence not only of the success of repairing concrete barges but of the practicability of concrete barges for the carrying of oil cargoes. This is all the more interesting in view of the present plans of the Shipping Board to construct a number of concrete oil tankers of 7,500 tons capacity and the projects of several private interests for a fleet of oil barges for the Mexican oil trade. Satisfactory results in the storage of fuel oil in concrete tanks and the greater knowledge now possessed of the requirements of concrete boat building make successful results all the more certain.

Concrete Barges

Concrete barge building has now been revived in the South—the first products being the two 550 ton barges that have been built by the J. W. Thompson Company near New Orleans, one of which is now in commission. These barges are 130 feet by 30 feet by 7½ feet at the center and 8½ feet at the rakes, drawing 2 feet 7 inches when light and 7 feet when loaded. Mr. Thompson in commenting on the first barge placed in service said:

"Concrete barge *Mila No.* 1 with 450 tons gravel made her maiden trip yesterday. She showed no leaks at all. Handled better at loading dredge and towed steadier than our wooden barges. I vote her a real success."

Interesting progress photographs have been received of the 500-ton concrete barge being built by the Interocean Barge & Transport Company, at Seattle, and give a good idea of the general type of construction and arrangement of interior framing, reinforcement, etc. This barge is 116 feet by 34 feet by 10 feet in general dimensions with a load draft of 8 feet. The hull is divided into watertight compartments by one longitudinal and four cross bulkheads. These are 4 inches thick, while the sides, bottom and deck are 3½ inches. The barge has a weight of 350 tons, which gives a ratio of deadweight to displacement of about 60 percent. Concreting is now completed after continuous operation from start to finish with the exception of a break at the deck line where a joint was made. It was reported that after over one hundred hours' continuous placing, the concrete gang stopped for five minutes to cheer the good ship *Faith* as she steamed up to Seattle on her maiden voyage—certainly a sufficient excuse for a few moments' delay.

In the East the 700-ton barge built by the Louis L. Brown Company has been launched, and other barges are now being built for the Navy Department, while there is every prospect of a large number of barges of this kind being built for service on the Erie Canal and other inland waterways. Concrete barges have proved their usefulness. The 200-ton *Pioneer,* built in 1910 for use on the Welland Canal, is still serving just as efficiently as when new, and has been subjected to severe tests. The barge has been loaded many times with carloads of rubble stone dumped from a height of 12 to 15 feet upon the concrete deck, the full load starting from one end, which procedure would doubtless make an oldtime wooden scow captain shiver. Answering a question recently in regard to the effect of loading stone thus, J. L. Weller, the designer and builder, has said: "The deck of the *Pioneer* is of 2½-inch concrete and has never been protected or covered in any way while stone was being dropped upon it. In probably half a dozen cases where a large stone dropped on its corner a dent was made on the surface; but this did not amount to anything and apparently has been patched up, as they are not noticeable, and the deck is now 99 percent, at least, in as good condition as when built."

The need is great for river barges to handle coal. About 50 percent of the wood coal barges used on the Ohio River for this purpose were lost in the ice jams last spring. We have given some study to this problem and have worked out a tentative design for a 500-ton concrete barge that may be of interest to those studying the same subject. The displacement loaded is 680 tons, giving a ratio of deadweight to displacement of 70 percent.

The barge has the same length and breadth as the wooden barge—i. e., 135 feet by 26 feet—and a slightly greater depth and is intended to be used in the fleets or separately as required. Results of experiments made by the Government and published in a bulletin "Experimental Towboats" indicated that for the draft and conditions under which this barge would be used the circular type of rake offered the least resistance in towing.

Brackets and cross beams 9 feet apart support the shell and top beams; but the brackets project only 2 feet inside, which should interfere little with loading or unloading. There are also longitudinal beams in the bottom, which is a double bottom for extra safety against sinking if the bottom is damaged and gives extra stiffness also. The shell is 2¾ inches on the bottom, decreasing to 2 inches at the top. The draft is 22 inches light and 6 feet 7 inches loaded (concrete 155 pounds). With the use of lighter weight concrete this could be reduced.

The floor might be cast with the rest of the barge or made of pre-cast sections placed later, thus simplifying forms, a wedge-shaped space left between the edges of adjacent slabs over the beams containing strap iron anchors, which, when encased in the concrete filling the wedges, hold the floor slabs securely. The wedges could be cut out when necessary to replace individual sections, the edges of the slabs being coated with tar.

A barge somewhat similar to this type has been used on English canals for handling ashes, etc.

Progress in England and France

England and France are making great strides in the construction of barges and lighters, many of them for sea-going service and others for the various canals and waterways. A good example of what a standard design and standardized forms can accomplish in the way of speed of construction is found in the yard of a French company located on the bank of the Seine. Here as many at 10 lighters about 125 feet long are under construction at a time, and production is said to average one vessel a week. The forms have been carefully designed not only to give the craft graceful lines but to facilitate assembling

and taking down, and, of course, are used repeatedly. It is stated that about 10 days' time is required to set the forms and place the reinforcement and 2 days to place the concrete, working continuously. After forms are removed the surface is smoothed by rubbing. When the craft is to be launched a large crane picks it up bodily and places it in the water. This crane also serves a useful purpose in handling forms, etc.

T. J. Gueritte, the French engineer whose paper on concrete boatbuilding was published in the June issue of MARINE ENGINEERING, says: "The author has seen in what was 4 months before a bare field two 1,000-ton barges ready for launching and several others following closely." He further makes the interesting point that with concrete, alterations in the design in course of erection can be readily effected in building both barges and ships of concrete, which undoubtedly has its advantages in some cases.

James Pollock and Sons Company, of London, have adopted the use of straight lines wherever possible for the small coasting vessels now building, to simplify formwork, but the J. & B. Stewart Company of London and Belfast, which has completed recently a sea-going barge, followed the usual ship lines. The vessel was apparently constructed in a dry-dock or slip and launched by filling the dock, which is somewhat the same procedure as has been proposed by some in our own country.

The 125-foot concrete ship built by the Atlas Construction Company, of Montreal, and launched last November, is practically ready for service. This vessel is interesting because of the use of structural steel frames which were encased in concrete at the time the concrete shell was cast.

WORK IN NORWEGIAN YARDS

The Norwegian yards, which were among the first to build concrete ships for ocean service, are continuing their activities. The Fougner yard at Moss completed in March, a 600-ton motor ship similar to the *Namsenfjord*, which is well known to shipbuilders, and is following this with 1,000 and 1,500 ton vessels, while the Fougner American yard is at work on concrete barges and several 3,500-ton ships. This company built the first floating drydock of reinforced concrete last year for a Christiania firm of yacht builders, the dock accommodating a vessel 75 feet by 25 feet and having a lifting capacity of 100 tons. The application of concrete to a floating structure of this kind is particularly interesting in view of the need for many floating dry-docks in connection with our rapidly expanding merchant marine. I understand that a company in San Francisco has about completed another floating dry-dock of concrete which has a capacity of 6,000 tons.

The Porsgrund Company, of Porsgrund, Norway, has also another lighter nearly complete similar to the 200-ton vessel launched last July, which is unique in that it was constructed and launched bottom up. The vessel was righted in the water by an ingenious arrangement of inner compartments whereby water was admitted to certain compartments, while others remained filled with air, thus anbalancing the craft so that it slowly turned over until it floated in correct position.

CONCRETE STEAMER FAITH

But it has remained for America to take the lead by the construction of the 5,000-ton concrete cargo steamship *Faith* on the Pacific Coast, and demonstrate that concrete was practicable for ocean-going vessels of large tonnage. It is tonnage of this class that we need now—this year—which by reinforced concrete construction can be supplied quickly and without interference to the construction of wooden or steel vessels.

Our lead should be maintained and a comprehensive programme of concrete ship construction vigorously prosecuted. The attitude of our English Allies toward this matter is strikingly emphasized in a remark of one of the Admiralty officials concerning concrete ships, that "Every encouragement is being given by the Admiralty; newly formed yards have been laid down specially, while existing shipyards have been encouraged to form branch establishments for the purpose."

When the construction of this vessel was begun in September, 1917, many were beginning to realize the magnitude of the shipping problem, but few had given thought to the possibilities of concrete construction in solving that problem. The construction has been quite generally described in print and will be shown in the motion pictures, so I shall not dwell on that here.

The shipping problem had become more fully understood by the time the vessel was launched on March 14 and chirstened *Faith*, and the success of this launching attached greater interest and importance to the concrete ship.

Early in May the *Faith* was completely fitted out ready for her trial trip—a record for such work on the Pacific Coast—and during the trials developed more than the designed speed of 10 knots which it was estimated the 1,750 horsepower engines would give.

The latter part of May the *Faith* took on her first cargo, salt and copper, and a few days later sailed for Vancouver via Seattle and Tacoma.

The maiden voyage of the *Faith* was as strenuous and severe a test as could be asked for in a concrete ship and she stood up under the gale, which at times put the decks awash, in splendid fashion, reaching Seattle—her first port of call—6 days after leaving San Francisco, in excellent shape, having taken in no water through the bottom.

Faith in concrete has again been justified. The application of a tried material to a known problem has again been accomplished. Concrete ships must be built in large numbers and with all possible speed to help answer the call for ships, more ships and still more ships, and win the war.

New Organization Formed to Boost Building of Concrete Ships

A NEW organization, the International Concrete Ship Association, composed of engineers and business men from all parts of the country, has recently been founded with a view to developing a practical working plan for building concrete ships to be utilized in aiding the overseas transportation problem. With ample capital, recognized engineering skill, and labor and shipway facilities at their disposal, the association proposes the building of 500 large reinforced concrete and steel ships, together with innumerable river, lake and canal craft, sixty percent of the tonnage of which it proposes to offer to the government at government rates. The capital of the component corporations and individuals is said to run into billions of dollars and their plants spread over the entire country.

PERSONNEL OF THE ORGANIZATION

The character and standing of the men who compose the association are sufficient endorsement for its potential efficiency. The board of consulting engineers includes such men as Theodore Ferris, naval architect, of New

York, Esplin Sons & McKnaught, Maurice Deutsch, Harold P. Brown, consulting and contracting engineer, and Alexander Brociner, New York. Victor C. Coxhead, from the state of Washington, who is chairman of the general committee of the association, represents eighteen interested companies in Puget Sound, four Eastern shipbuilding yards, and four Canadian shipbuilding companies; he is also a member of the War Industries Committee of the Pacific coast and has direct charge of the coast west of the Cascade Mountains. Mr. Coxhead has come East to give his entire time to this proposed concrete ship fleet, working from the association's national headquarters, 7 East Forty-second street, New York, and from room 470, Woodward Building, Washington, D. C., in conjunction with John W. Clifton, counsel of the association and its general representative at the capital.

The executive committee of the association is composed of R. C. Morris, of New York, chairman; Guy Vroman, of New York, formerly engineer of the Catskill Aqueduct; Maurice Deutsch, consulting engineer for a number of Eastern companies; John F. Pell, representing several concrete shipbuilding companies, and Albert Oliver, of Albert Oliver & Son, general contractors of New York.

Others who are giving their time to the details of the work are Robert F. Hall, well known in connection with the Portland Cement Association and now general manager of the Lime Association of the United States, cement representatives of the largest concrete producers, manufacturers of concrete making machinery; concrete material men and numerous individuals throughout the States who are connected with the concrete industry, naval architecture and allied engineering.

Feasibility of Concrete Ship Construction

At the founding meeting of the association held in New York on July 24—at which H. J. Brunnier, of the Emergency Fleet Corporation, representing Mr. Schwab, and Captain Robinson, of the Government Transport Department, were present—Frank Van Vleck, appearing as General Goethal's representative, said:

"I can say on behalf of General Goethals that he is very much interested in the reinforced concrete ship, and he is willing to back up his reputation, as the builder of the Panama Canal, where reinforced concrete made the building of it possible—he is willing to back that reputation on the building of concrete ships, and with that in view he has asked the Transportation Department of the War Department definitely to commit themselves in regard to concrete boats.

"We have already let contracts for some twenty-five concrete vessels, and we are to open bids in a few days for concrete barges, and we are designing other vessels that may go up as high as seven thousand tons. The general feeling in all these cases is that it is simply a matter of good design, of good construction, of good naval architecture, and results can be accomplished which will help to solve the problem.

"In other words, the War Department has committed itself to a policy of not placing contracts for vessels—wood, steel or concrete—in any yards which are doing Shipping Board work or navy work. That being so, it almost inevitably drives the War Department into the yards of new contractors, who are willing to start on almost nothing and are willing to entertain concrete or other unusual methods of construction. As a war-time measure, it feels perfectly justified in going ahead and encouraging contractors in undertaking these new things."

The recent statements of R. J. Wig, chief engineer at the head of the concrete division of the United States Shipping Board, declaring that recent tests of concrete structures in sea water have shown that they will last years without any protection whatever, come from an unprejudiced expert. He has also stated that few people realize that the concrete ship is actually 20 percent lighter than the wooden ship, if built of a new concrete mixture developed by the Emergency Fleet Corporation. "It is so light, in fact," continues Mr. Wig, "that a block of it floats on the water, and yet it makes the kind of concrete possessing twice the strength of that used in ordinary building construction."

The members of the association, men who have had long experience in every branch of the concrete business, believe that reinforced concrete offers the solution of the shipbuilding material problem. They assert that they can begin work at once without interfering in any way with any of the government shipbuilding plans. The association points out that structural steel is not used in the concrete ship, so the building of the proposed fleet would not interfere with government plans for steel ships; also that the only steel which enters to any extent into the construction of a reinforced concrete ship is bar steel, of which there are now on hand in warehouses sufficient quantities to build 13,000,000 tons of concrete ships.

Future Developments

The association's data, issued by its secretary, H. F. Cuntz, on August 1, shows the following permits for concrete craft construction:

Firm	Vessels	Date
Universal Shipbuilding Company, Sturgeon Bay, Wis.	12 reinforced concrete barges 1,500-2,500 tons deadweight and 6 barges 1,000-2,000 tons deadweight.	1918 March 7
J. L. Weller, Tonawanda, N. Y.	30 reinforced tow barges, 575 tons deadweight.	May 8
Concrete Steel Shipbuilding Company, Savannah, Ga.	1 concrete freighter and 1 reinforced concrete barge 500-600 tons deadweight.	May 24
S. S. Saxton Company, Chicago, Ill.	5 concrete tankers 3,500 tons deadweight.	May 25
Concrete Shipbuilding Company, Newburgh, N. Y.	4 reinforced concrete capsule shape 2,500 tons deadweight.	May 27
Delta Shipbuilding Company, New Orleans, La.	12 1,000-ton river barges.	

This building, totaling only approximately 83,750 deadweight tons of concrete craft, includes ten motorships and sixty-one barges for river and ocean service.

This record should show, the association claims, 750,000 tons by September first and at least 2,000,000 tons by October first.

Besides the above, the government has let contracts to five yards for eight 7,500-ton ships each, which alone totals 300,000 tons to be built at yards in San Diego, Cal.; Mobile, Ala.; Wilmington, N. C.; Jacksonville, Fla.; San Francisco, Cal.

The immediate utilization of the $50,000,000 (£10,250,000) which the government has already appropriated as an *emergency* fund to build concrete cargo hulls would, the International Shipbuilding Association believes, go far toward supplying the twelve to fifteen million tons of ocean transport needed for adequate service. The members of the association hope that the result of their concentrated efforts will be to make it possible for the Emergency Fleet Corporation and the War Department to accept their assistance and capital to build up a great future for the American merchant marine.

An eight-inch periscope is a very small percentage of the Atlantic Ocean. Remember the fact when you tell your friends the United States Navy ought to sweep the ocean free of submarines.

Fig. 1.—Class of House Carpenters Attending Night School in Newburgh to Obtain General Knowledge of Ship Construction

Overcoming the Labor Problem at the Newburgh Shipbuilding Company Plant

Home Labor Utilized by Efficient Training in Night School Courses—Instruction Continued in the Shipyard

(Photographs Copyright by Publishers Photo Service, N. Y.)

WHEN the Newburgh Shipbuilding Company began operation at Newburgh, N. Y., in the winter of 1917, the organizers were confronted with the difficult problem of securing efficient shipbuilding labor from a depleted market. Labor of this class had long since been drawn at high wages by competing yards. The company tackled the task in true Yankee fashion.

Like many Eastern inland cities of 35,000 inhabitants, Newburgh engages in varied industrial pursuits within her borders and also draws capital and trade from the surrounding agricultural district. Shipbuilding, however, was a new industry. To meet the situation, it was planned to select the more efficient and more ambitious workmen from the home market, by using the attractive wage and patriotic appeals, and to train these men to the varied tasks of the shipbuilder. Shipbuilding night schools were organized under the regular city night school system and were conducted as a part of it. When the lists were opened for enrollment in the early part of the winter, the great number of applicants made it necessary to establish four classes, each class receiving two evenings' instruction during the week. This arrangement kept many applicants upon a long waiting list, and even at present the enrollment in the shipbuilding classes far exceeds the total enrollment in all other classes in former times.

Two separate courses are given. The first is essentially practical. Inexperienced men are taught riveting, chipping and calking from the simplest operations up. These

Fig. 2.—Instructing Shipfitter Students How to Make Templates on Ship Under Construction

Fig. 3.—Men Riveting on Ship Under Supervision of Trained Mechanic After Receiving Night School Training

Fig. 4.—Shipfitters Applying Knowledge Gained in Night School to Actual Work in Shipyard

Fig. 5.—Heater Boys Learning to Heat Rivets Under Supervision of Instructor

Fig. 6.—Making Templates from Lines on Mold Loft Floor

Fig. 7.—Constructing Mold for Furnaced Plate

classes are conducted in the basement of the school building with regulation pneumatic tools. Compressed air is supplied by a small compressor plant. Under the supervision of instructors the men work on iron boxes, which are later used in the shipyard for storing small parts. Everything the men do, from the time they first touch a tool, is practical constructive work. Each product is

Fig. 8.—Calking Deck Seams

utilized. Every rivet driven is helping the shipbuilding programme. This fact alone gives the men a great interest in their work. The men enrolling in these classes are usually a husky and hardy lot, accustomed to heavy manual labor. Many farmers have become riveters and prove to be the most useful workmen. One farmer walked several miles to school every night after completing his regular farm work during the day. He soon finished his course and was put to work on the ship, where he is now driving more rivets per day and making more money than old-time riveters working beside him. His wages run from $60 to $70 (12/10/0 to 14/11/8) a week, a rate above the general average wage. Other trades which are drawn on for riveters are stone masons, blacksmiths, stevedores, bargemen and brickyard employees.

At present the period of night school instruction extends over three weeks. At the end of this time the men who show most aptitude in the class are put in the shipyard under an instructor and paid at the rate of forty cents (1/8) an hour. Those remaining in the class continue their night work, and when they show sufficient proficiency are taken on, provided the work in the yard warrants new employees. The yard has a group of teachers—men who have taken the instruction course in the government shipbuilding school at the Shipping Board Training Center in Virginia. Each instructor has four to eight workmen under him. He does no work himself, but closely supervises every move of his pupils. Every rivet which a pupil drives is real work accomplished—not mere practice on extra material. When the student goes on a ship every rivet which he drives in the hull will remain as long as the ship is afloat. After three or four weeks' work on the hull under supervision, the workman is graduated and receives the regular government scale of wages.

The second course, known as the "Ship Information and General Construction Course," gives carpenters, steamfitters, electricians and men from allied trades a general comprehensive knowledge of the form, construction and names of the different ship parts, so that when they go down to work on the ship and are told to go into the forward hold they will know at once where to go. The men who take this course are usually skilled mechanics. They need only the new language and new application of well-learned facts to be converted into shipbuilders. This advanced course also includes mechanical drawing and blue print reading, which is essential to the mold loftsman and the ship framer.

The men who have been carpenters before, and who have completed the second course, are at once used as ship framers and work in the mold loft. The system of supervision, graduation and payment is essentially the same as for the riveters.

It is interesting to note that the personnel of the Newburgh shipyard is far above that usually found about shipbuilding plants. The men are quiet, clean, sober and industrious, each intensely interested in his work, and each apparently having a higher and broader outlook on life than the pay envelope gives. They work with an earnestness and industry which speak well for the shipbuilding night school course.

Training Workers for Wooden Shipyards

New Course of Instruction Organized at Pratt Institute, Brooklyn, N. Y., for Woodworkers in Shipyards

A NEW course of instruction has been especially organized by Richard M. Van Gaasbeek, head of the woodworking department in the School of Science and Technology, Pratt Institute, Brooklyn, N. Y., to serve in the present national need for increased productive efficiency in the shipbuilding industry by aiding in supplying the extraordinary demands for skilled ship workers arising from the war.

Extent of Instruction

The instruction is arranged to give to house carpenters and other skilled woodworkers a practical understanding of wooden ship and boat building, including also woodwork on steel ships, with a view to helping such men to become competent workers in the great shipbuilding industry now rapidly developing in this country. The course is open only to experienced woodworkers in the trades mentioned, and is intended to be taken either just before or just after transfer to shipwork. The school is in a position to assist men taking in this course to obtain employment in ship and boat building yards.

Outline of the Course of Instruction*

The experienced ship woodworker who wishes to broaden his knowledge of modern wooden ship and boat building practice will find in the advanced term of this course instruction well suited to his requirements.

It has been the aim to establish a fundamental course that will help the shipbuilder as well as the boat builder;

* The facts in this portion of the article are taken from a paper by Richard M. Van Gaasbeek, appearing in the current issue of *The National Marine*. Photographs by Publishers Photo Service, N. Y.

Fig. 1.—Picking Up Lines from Mold Loft Floor

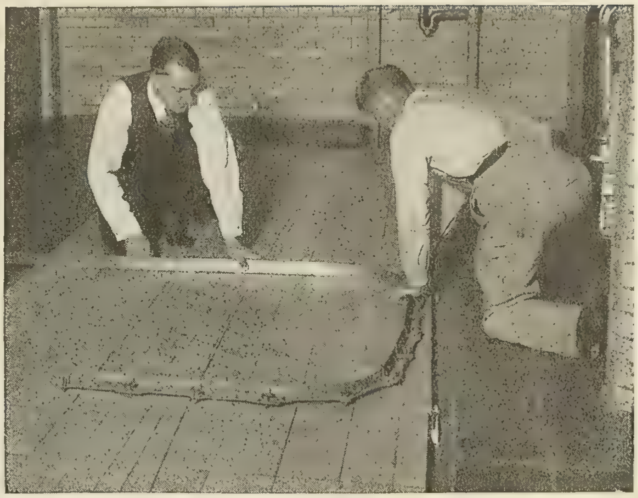


Fig. 2.—Picking Up Lines with Flexible Steel Template

Fig. 3.—Students Practicing Light and Heavy Calking

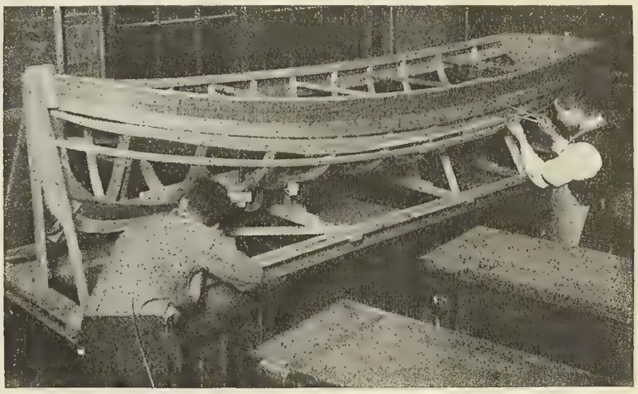


Fig. 4.—Spiling for First Lower Strake of Planking

for whatever may be the size or type of the vessel under consideration, the general principles of construction remain very much the same in all cases. To build a full size ship was out of the question. The cost of the lumber, the space and equipment necessary to handle the heavy timbers, the extra heavy work that would be required of the men after a hard day's work, and the length of time it would take to complete their training are factors that had to be considered in selecting a problem that would meet the emergency situation.

Since laying down the lines of a vessel on the mold loft floor calls for a knowledge of the principles of descriptive geometry not possessed by the average mechanic, Mr. Van Gaasbeek does not believe that the proper place to begin the training of a new recruit to the boat or ship building industry is in the mold loft. The lines of the vessels that have been laid down on the mold loft floor in Pratt Institute have all been laid down as a class problem under the direction of an instructor, with no special effort made to have the student thoroughly understand the lines during the preliminary period of his training. Later, when the students have picked up their lines and made their molds and applied them in the construction of their problem, their minds are more receptive and they can absorb and understand the principles as they are presented by their instructors. At this later period emphasis is then placed upon principles rather than construction.

Basic Principles Taught

Accordingly, two men are assigned to each side of a boat and begin their training with the picking up of the lines from the mold loft floor and the making of their molds through to the completed boat.

Special instruction and practice work is given in sizing and scarphing heavy yellow pine timber, calking (both light and heavy work), and steam bending of materials. The shop is equipped with a modern mill plant of woodworking machinery, including joiners and surface planer, circular and band saws, mortise and tennon machines, jig saw and boring machines—all motor-driven. Also sixty benches, each with a complete outfit of hand tools.

Each student is taught to get out his stock from the rough timber to the finished product, and those who master this course are qualified to direct the labor of others because they have learned by doing. It is by manipulative skill that a practical understanding can best be acquired.

This course is not only recommended to carpenters and other woodworkers who are transferring to the boat and ship building industries, but is also advised for those already in the industries who have, because of circumstances, been compelled to specialize in one branch or another and now wish to broaden their knowledge of

wooden boat and ship building practice in order that they may take advantage of the many opportunities that are now being offered. The course is designed to help and is equally valuable to men working on steel ships who wish to study the underlying basic principles of ship construction in order that they may prepare for greater responsibilities.

Parts of Vessel to which Application of Electric Welding Has Been Considered and Approved by American Bureau of Shipping and Lloyds

ALTHOUGH the classification societies are proceeding very cautiously in approving the application of electric welding to new ship construction, because of the lack of a reliable system of testing the quality and strength of the welds, nevertheless both the American Bureau of Shipping and Lloyds now approve the welding by electricity of the following parts of steel vessels:

Deck rail stanchions to plating.
Clips for detachable rail stanchions.
Continuous railing rods (joints).
Attaching deck collars (L rings) around ventilators.
Attaching deck collars (L rings) around smoke stack.
Attaching cape rings around smoke stack, pipes, etc.
Attaching galley fixtures to plating.
Attaching bath and other fixtures in officers' quarters.
Attaching cowl supporting rings to ventilators.
Bulwark rail top splicing and end fitting.
Skylights over galley.
(*a*) Engine room stairs and gratings.
(*a*) Boiler room stairs and gratings.
Attaching (*a*) and (*b*) to plating grab rods on casing.
All stairs and ladders, including rail attachments.
Door frames to casing, hinges, catch holds, coach-hooks, etc.
Clips for attaching interior wood finish to casing.
Entire screen bulkhead.
Coal chutes.
Butts of watertight and oiltight boundary bars on bulkheads or floors in double bottom.
Ventilator cowls.
Stacks and uptakes.
Bulkheads (that are not structural parts of the ship), partition bulkheads in accommodation.
Framing and supports for engine and boiler room flooring or gratings.
Cargo batten cleats.
Tanks (that are not structural parts).
Shaft alley escapes.
Steel skylights over accommodation spaces.
Engine room skylights.
Grab rods on exterior and interior of deck houses.
Deck houses not covering unprotected openings through weather decks.
Reinforcing and protecting angles around manholes.
Joints of watertight angle collars at frames in way of watertight flats.

The undertaker's friend is the man who "did not think" or who thought the job "was good enough." It is a great temptation when crews want to get ashore to slight the repair job. Don't do it; it may mean your life or that of some one else later.

Handy Method for Laying Off Tank Margin Plates

BY J. A. RIDLEY*, NAVAL ARCHITECT (SOUTH KENSINGTON)

THE following method, original as far as the writer is concerned, seems particularly applicable to the standard type of cargo steamer now being built on the Great Lakes for the Emergency Fleet Corporation, owing to the simple arrangement of the margins with the same slope throughout and being straight lines along the knuckle from butt to butt.

I am assuming that all who are interested in this article will have a general knowledge of fairing up the lines of a ship and that the margins are already marked in place on the body plan as usual for templating frames, floors, etc.

In every method you will have the inboard bend or knuckle line produced in the half breadth plan, i. e., straight from butt to butt, and I propose to hinge the margin plate at this line and swing up into the expanded or true shape in the half breadth plan.

You will first project the outboard edge of the margin in the half breadth plan by measuring on the body plan the half breadth of this edge at each frame section and placing these on the same frame sections in the half breadth plan and drawing a line through the spots.

If you now mark on the floor the inboard edge of the plate, including the lap and butts on the tank top, you have a complete projection of the margin in view, in direct connection with the tank top, handy for marking both together.

You now take on record the girth or width of each margin on the body plan from the tank top to the frame line. It is a good plan also to record the vertical height of each margin for a check on the former.

Next, to lay off the plates on the half breadth plan, tack a straight edge to the margin knuckle as shown, and with a square produce a line through the intersection of the frame and the outboard edge of the margin long enough to take *E* the width of margin at that frame, which width can now be applied from the straight edge at the frame intersection, giving a point for the true shape of the outboard edge of the plate. A line through this to the point at the straight edge gives the true frame line at that station.

Repeat this operation at each frame and also at the middle line of butt.

A good way is to find the outboard spot *D* first by using the vertical height check *A* referred to and then place the square in the position shown. Put the vertical height on for leg *A*, then take the hypotenuse or length *C* and place it along the other leg *B* to *D*, giving a spot which equals or checks the previous one explained.

The last method mentioned is used particularly at the middle line of butt, the vertical height in this case being the one taken from the nearest frame.

The explanation seems lengthy, but the operation is really short and simple. Other details are better left to the individual himself—once he grasps the main principle.

It is best to take the center of thickness or the neutral axis of the plate in all this kind of operations.

When the tank rises toward the center line of the ship you can easily correct the slight difference this makes in a few of the frame lines and butts. It is best to think those points out for yourself to avoid confusing explanations.

The method described would be unsuitable for some vessels, but on these particular steamers it seems to be a

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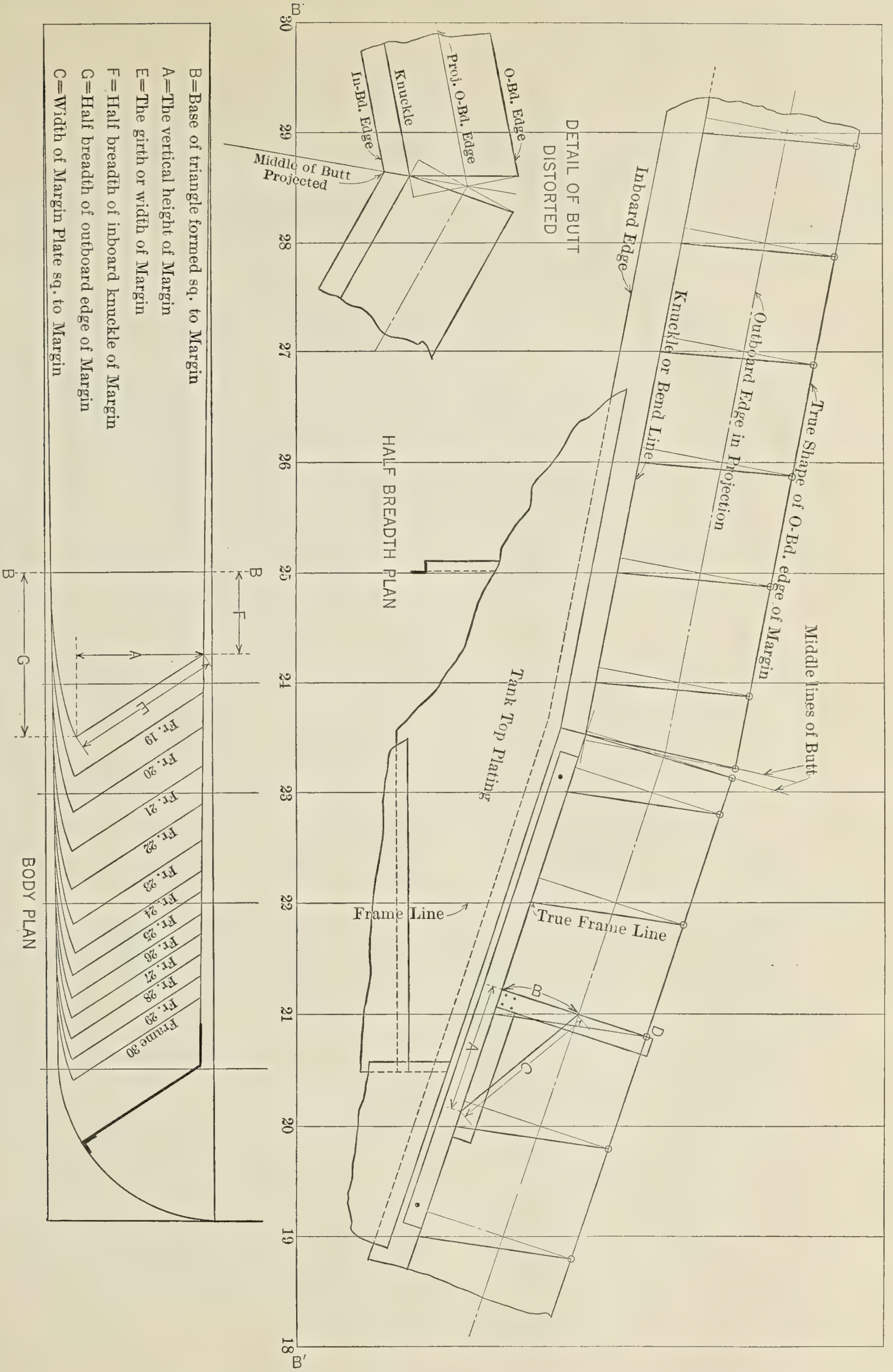


Sketch Showing Method of Laying Off Tank Margin Plates

ready and quick job. It accurately accounts for the irregular length of elbow at butt spaces and is right on the spot for attaching to tank top plating, through being developed on the same plan as its arrangement is shown.

Lloyd's Technical Committee Thoroughly Investigating Application of Electric Welding to Shipbuilding

A SPECIAL meeting of the technical committee of Lloyd's Register of Shipping was held recently in London to consider the subject of the application of electric welding to shipbuilding to the extent of eliminating by this method the use of rivets for important structural connections.

Electric welding has, of course, been employed for many years for ship repair work, but its use has been practically confined to parts of the structure not likely to be exposed to important stresses. It is, in fact, only since the early days of the war that such appreciable developments have been made as to appear to afford justification for the great extension now contemplated.

In view of the importance of the subject to the shipbuilding industry of the world, the committee of Lloyd's Register of Shipping have recently carried out a series of carefully devised experiments to determine, as far as can be done by means of tests and analyses, the general trustworthiness of structural connections effected by electric welding and their capacity to stand the strains to which they would be subjected in practice.

The technical committee had before them a report from the Society's chief ship surveyor, setting forth in detail the results of these experiments and dealing very fully with the whole subject.

Demonstration Given

In order to assist the technical committee in their deliberations and to afford others interested an opportunity of witnessing the system in operation, a demonstration was given at the Society's offices in Fenchurch street. Among those present were:

Sir Thomas L. Devitt, Bart., chairman; Sir Edward E. Cooper, deputy chairman, and Sir Thomas J. Storey, K.B.E., chairman of classification committee of Lloyd's Register of Shipping; the Right Hon. Sir Joseph Maclay, Bart., shipping controller; R. B. Stevens, vice-chairman, and J. R. Gordon, one of the members of the American shipping mission; Sir Alfred Yarrow, Bart.; Sir William Beardmore, Bart.; Sir Frederick W. Lewis, Bart.; Sir Thomas Royden, Bart.; Sir Owen Philipps, G.C.M.G., M.P.; Sir Kenneth S. Anderson, K.C.M.G.; Sir Thomas Bell, K.B.E., deputy controller for dockyards and repairs; Sir E. H. Tennyson d'Eyncourt, K.C.B., director of naval construction; Engineer Vice-Admiral Sir G. G. Goodwin, K.C.B., engineer-in-chief of the fleet; Sir George B. Hunter, K.B.E., D.Sc.; Sir George Carter, K.B.E.; Sir Alexander Gracie, K.B.E., M.V.O.; Sir Frederick N. Henderson, K.B.E.; Lieutenant-Colonel Sir Robert S. Horne, K.B.E., Civil Lord of the Admiralty; Sir John Esplen, K.B.E.; Rear-Admiral L. E. Power, C.B., C.V.O., director of dockyards and repairs; Graeme Thompson, C.B., director of transports and shipping; Charles I. de Rougemont, chairman of Lloyd's; J. Herbert Scrutton, vice-president of the Chamber of Shipping of the United Kingdom; Capt. H. B. Hooper, chairman of the London General Shipowners' Society, and Edward F. Nicholls, chairman of the Institute of London Underwriters, as well as representatives of the American, French, Italian and Japanese governments.

Speaking at the informal luncheon which took place after the meeting of the committee, Sir Thomas L. Devitt, Bart., said:

"I would like to say in a few words how very pleased we are to have with us to-day the friends who have honored us with their company to see what we have to show them regarding the proposed application of electric welding to shipbuilding. This subject is one of far-reaching possibilities, and when it came before our committee some months ago they considered that the Society should undertake some practical experiments with a view to testing the reliability of the process.

"These experiments have been carried out under the direction of Mr. Abell, our chief ship surveyor, and with the kind co-operation of Messrs. Cammell Laird & Company, Ltd.

Recommendations of Committee

"They have been fully considered by our technical committee at their meeting to-day, with the result that it has been decided to recommend to the general committee that, under certain conditions to be adopted as a tentative measure, welding may be approved in vessels intended for classification in Lloyd's Register of Shipping.

"I need not enlarge upon the importance of this decision, which will be fully appreciated by this eminently practical assembly. I will only say that the committee of Lloyd's Register of Shipping are pleased to place at the disposal of the shipping community of this country, and of all the Allied nations, the services of the Society's highly trained staff of surveyors, and of its distinguished technical committee, in the consideration of the many complex problems which we have constantly to face in naval architecture and marine engineering.

"The war has brought with it fresh problems in the realm of naval achitecture; and, speaking with a long experience in shipping, I can say without hesitation that never at any time has the Society of Lloyd's Register of Shipping been more anxious to act as 'the guide, philosopher and friend' of the great shipping interests, and never has it been better equipped to handle all such problems than it is at the present time.

"It affords me particular pleasure to welcome here today the honored representatives of our Allies in the great struggle in which we are engaged.

Tribute to Allies

"We have with us to-day Mr. Stevens, the vice-chairman of the American shipping mission, and Mr. Gordon, another member of that mission, who is also a member of the American Committee of Lloyd's Register of Shipping, as representatives of our cousins and allies across the Atlantic, who, in pursuance of high ideals and in full recognition of the claims of humanity and civilization, are displaying such vast energy and vigor in support of the cause of liberty and international justice.

"We are likewise honored with the company of representatives of heroic France, valiant Italy and gallant Japan, and we join with them in praying for victory to our arms.

"May I say how pleased we are to have the company of Sir Joseph Maclay, and of the able members of his staff in the Ministry of Shipping? Sir Joseph Maclay has brought to the discharge of his most arduous office abilities of a high order, wide practical experience and shrewd common sense, and he has done much by his capable handling of shipping to make it possible, like Joseph of old, to feed the people; for, in reality, Sir Joseph Maclay, as shipping controller, has also been the food controller, as without a proper use of our ships there would have been little food to control."

Adaptability to Shipbuilding of Craftsmen from Outside Trades

Occupational Analysis of Shipyard and Kindred Outside Trades Used to Classify Craftsmen Suitable for Training as Shipyard Workers

THE following, first published in *U. S. Employment Service Bulletin*, is based upon an occupational analysis of shipyard trades and kindred outside trades made by the Federal Board for Vocational Education. It is published here for the information of those interested in the task of recruiting and training workers for shipbuilding.

For purposes of comparison with outside trades, the shipbuilding trades are divided into three classes:

Class 1.—Shipbuilding trades in which there is no corresponding outside trade, but for which experience in certain trades is an asset.

Class 2.—Shipbuilding trades in which there is a corresponding outside trade, but for which additional special training is necessary for satisfactory work in shipbuilding.

Class 3.—Shipbuilding trades into which outside craftsmen may come without additional special training.

Class 1

Following are the shipbuilding trades (in italics) in which there is no corresponding outside trade. The outside trades listed with each shipbuilding trade are kindred trades in which experience is an asset:

Mold loftsman.—Structural template maker, structural marker or layer out, sheet metal worker, house carpenter, cabinetmaker, naval draftsman, structural, architectural, or mechanical draftsman, and pattern maker.

Shipwright or ship carpenter.—Master carpenter or contractor, house carpenter, rough carpenter or handy man, bridge carpenter, house mover, dock and wharf builder, piledriver man, lumberjack, lumber-yard and sawmill man, millwright, erecting engineer, liner on structural-steel work, machine erector or road man, structural or bridge erector, and elevator constructor.

Ship fitter.—Structural marker, structural fitter, structural erector, structural template maker, structural yardman, and structural draftsman. (Trades less allied, but experience in which is an asset, are blacksmith, boiler maker, sheet-metal worker, ornamental and architectural ironworker, jobbing machinist or auto-repair man, and house carpenter.)

Anglesmith and plate and shape furnaceman.—Blacksmith, horseshoer, wheelwright, blacksmith's helper, striker, back handler, ornamental and architectural ironworker, and steel-mill man.

Rigger and sailmaker.—Sailor and tent and awning man.

Wood calker.—No outside kindred trade, except the somewhat lighter calking done on launches, pleasure boats, and other small craft.

Class 2

Following are the ship trades in which there is a corresponding outside trade, but for which some special training is necessary. The corresponding trades are listed after each of these ship trades:

Marine plumber, marine pipe fitter, and marine coppersmith (pipe-shop trades).—Any experienced journeyman plumber, pipe fitter, or coppersmith can become competent on ship work in a short time and with very little special training. In recruiting men for ship work, these three trades should be drawn upon, as there are no other kindred trades and the common fund of trade knowledge and skill is very large.

Sheet-metal worker.—Heating and ventilation man, tank man, sheet steel and wire mesh locker man, blowpipe man (who installs blower systems in woodworking plants), and cornice man.

Ship joiner.—Cabinetmaker or joiner, furniture maker, and carpenter with experience on inside finish.

Ship electrician.—Inside wireman with experience on conduit work, telephone switchboard man on intercommunicating systems, telephone installer, trouble shooter, and wire chief, repair man on motors and generators, armature winder, and switchboard installer.

Blacksmith.—Hammerman and heavy forger, machine blacksmith, shipsmith, drop forgers, tool dressers, and helpers and strikers.

Outside machinist.—Erecting man on steam engines, turbines, machine tools, or any form of heavy machinery; erecting specialist on gas engines; millwright, erecting man on steam boilers; automobile and gas engine repair man or assembler; and elevator constructor.

Metal chipper and metal calker.—Structural steel worker on tanks, boiler maker used to calking on boiler seams, stonecutter and quarryman accustomed to use of mallet or air hammer and chisel.

Riveter.—Structural riveter and tank riveter. Chippers and calkers are often trained as riveters, since they can use an air hammer.

Class 3

Shipbuilding trades into which the outside craftsman may come without additional special training are:

Machinist.
Boiler maker.
Diesinker.
Pattern maker.
Yard rigger and craneman
Acetylene welder and burner.
Electric welder.
Molder.
Core maker.
Driller and reamer.
Galvanizer.
Machine operator in steel mill or ship shed.
Painter.

COMPARISON OF SHIPBUILDING AND KINDRED OUTSIDE TRADES

Trades Outside of Shipyards	Shipyard Trades in Which These Craftsmen May Be Used
Architectural iron worker	Anglesmith.
Asbestos workers	Pipe coverers.
Auto repair men	Ship fitter. Outside machinist.
Blacksmiths— Railroad blacksmiths Machine blacksmiths Hammer men Tool dressers	Blacksmith. Hammer men. Tool dressers. Shipsmiths. Anglesmiths. Plate and shape furnace men. Ship fitters.
Boiler maker	Boiler maker. Ship fitter. Flange turner.
Bricklayer	Pipe coverer. Cementer.
Bucker-up. (*See* Riveter.)	
Cabinet maker	Joiner. Template maker.
Carpenter	Ship carpenter (Shipwright). Ship joiner (if he has had experience on inside work). Mold loftsman. Ship fitter.

Carvers	Carving (in joiner shop).
Carriagesmiths Wagonsmith Wheelwright	Blacksmith. Anglesmith. Plate and shape furnace man. Ship fitter.
Chipper	Chipper (in foundry). Chipper (in yard and on ship). Calker (steel). Riveter.
Concrete man	Cementer. Pipe coverer.
Core maker	Core maker.
Coppersmith	Coppersmith.
Dock builders	Ship carpenters (stage builders).
Drop forger	Drop forger.
Engineers, steam	Outside machinists (if they have had erecting or repair experience). Pipe fitters.
Erecting engineer or road man	Outside machinist. Shipwright.
Elevator constructor	Outside machinist. Shipwright.
Electrical workers—	
Outside man	Outside wireman in yard.
Inside wireman	Wireman on ship.
Telephone installer Wire chief Trouble shooter Switchboard man	Wiring on intercommunicating systems.
Motor repair man	Motor repairer and installer.
Armature winder	Armature winder.
Galvanizer	Galvanizer.
Gas fitter. (*See* Pipe fitter.)	
Granite cutters Stone cutters Quarrymen	Chippers and calkers. Drillers and reamers.
Heater. (*See* Riveter.)	
Horseshoers	Blacksmith. Anglesmith. Plate and shape furnace man (or helpers). Ship fitter.
House mover	Shipwright.
Lumberjacks	Ship carpenters. Lumber handlers and stage builders.
Machinists	Floor hands. Bench hands. Machine hands. Machine operators. Outside machinists.
Molders	Molders of all kinds. Green sand, dry sand, bench, side floor and floor, cast iron, steel and brass.
Ornamental iron worker	Anglesmith.
Painter	Painter.
Pipe fitters— Steam fitter Gas fitter	Pipe fitters.
Pile-driver man	Shipwright.
Plumbers	Plumbers.
Painters	Painters (wood and metal).
Passer. (*See* Riveter.)	
Plasterers	Pipe coverers, cementers.
Quarrymen. (*See* Granite cutters.)	
Riggers	Yard riggers. Bolter-up.
Riveters— Structural Tank Automobile	Riveters.
Bucker-ups	Holder-ons.
Passers, heaters	Passers, heaters.
Sailors	Rigger (in rigging loft).
Steam fitter. (*See* Pipe fitter.)	
Structural iron workers—	
Structural marker	Ship fitter. Loftsman.
Structural fitter	Assembler or bolter-up. Ship fitter. Loftsman.
Structural liner or regulator	Shipwright. Assembler. Ship fitter.
Structural erector	Assembler or bolter-up. Ship fitter. Shipwright. Riveter.
Structural template maker	Template maker. Loftsman.
Structural draftsmen	Draftsman. Mold loftsman. Ship fitter.
Structural yard man	Material man. Cold sawyer. Yard man.
Sheet-metal worker	Sheet-metal worker. Ship fitter. Mold loftsman.
Tent and awning maker	Sail maker.
Wagonsmith. (*See* Carriagesmith.)	
Wheelwright. (*See* Carriagesmith.)	
Wood finisher	Wood finisher.

Note.—Helpers in practically all of these trades can be used.

Boat Lowering Appliances*

BY J. R. HODGE

At the present time, when our seagoing members are valiantly pursuing their occupations under unusual conditions, they are entitled to every consideration which minimizes their risk. Accordingly, this opportunity is taken to introduce the subject of boat-lowering appliances with a view to bringing out discussion upon the merits of

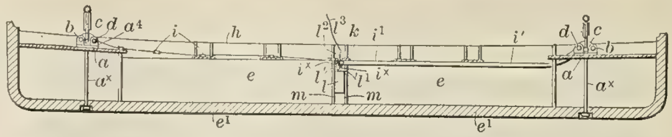


Fig. 1.—Longitudinal Section of a Ship's Boat to Which Disengaging Gear Is Applied

the gear described below, which overcomes the disadvantages associated with the lowering and disengaging of boats in emergencies at sea.

The type of apparatus evolved is for disengaging gear simultaneously and automatically at both ends of the boat,

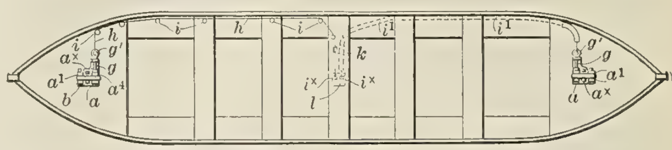


Fig. 2.—Plan Showing Connection of Disengaging Gear With Central Releasing Apparatus

to free it from the davit falls or tackles as soon as the boat is water borne.

The disengaging gear consists of a hinged or pivoted curved link at each end of the boat adapted to be hooked to the falls or other tackle for hoisting and lowering the boats; means for releasing the link; chains or ropes connected to a suitable place in the boat and to a weight. As long as the boat is suspended the links cannot move, con-

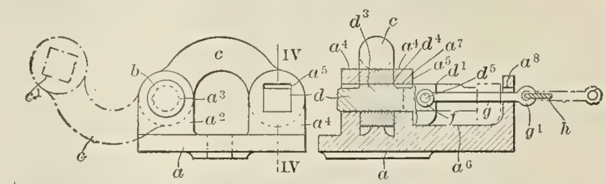


Fig. 3.—Front Elevation of the Disengaging Gear

sequently the weight cannot fall or move by gravity. As soon as the boat becomes water borne and the tension or pull on the curved links ceases, the weight is free to move or fall. In so doing it releases both links and the boat is disengaged from the falls or tackles. The boat is provided at each end with a metal plate base or bracket furnished with means for attachment to the boat at or near each end. Hinged or pivoted to each base plate is a link adapted to engage with the davit falls or hoisting and lowering tackle; a bolt or catch is also mounted on the base plate to engage with the free end of the link. Bolts in the base plate are each connected by a suitably guided chain or wire rope to a weight, which is thereby suspended in the middle or other convenient part of the boat.

The base plate *a*, bolted to the keel e^1 by a screw or bolt a^x, is made somewhat in the shape of an L, Fig. 1. One member, a^1, (Fig. 2) is provided at each end with two perforated lugs; one pair of these lugs, as shown in

* From a paper presented before the Institute of Marine Engineers, London, April 16, 1918.

Fig. 3, is furnished with round holes in line with each other to receive a pin *b*, on which is mounted one end of a similarly perforated and bent link *c*; the lugs at the other end are provided with approximately square perforations, and the other end of the link *c* is similarly perforated to receive a square bolt *d*. This bolt has a square head flattened on one side so as to rest and slide on the top of the other member of the base plate, which not only serves as a guide but is also adapted to limit the movement of the bolt. As an additional safeguard, the central portion of the bolt may be a little thicker in the middle than at the ends, so as to form a projection d^3, the edge of which facing the head d^1 may be chamfered at d^4. The square hole in the bearing for the bolt is also correspondingly chamfered at a^7, the object being to form a kind of lock or safety device to prevent the bolt from being prematurely or accidentally withdrawn until the boat is entirely water borne. As soon as this occurs the bolt drops onto the bottoms of the holes. The projection d^3 is then below the level of the chamfered edge a^7 of the square hole in the bearings. The end of the bolt has a transverse hole d^5 to receive a pin for connecting thereto the fork of a forked rod *g*, which passes through a hole in a lug, a^8, also adapted to limit the movement of the bolt. The other end of the forked rod is connected to a chain or wire rope *h*, which is suitably guided around guide pulleys or fairleads *i*, as shown on the left-hand sides of Figs. 1 and 2, or through pipes or tubes i^1, such as shown on the right-hand side of these figures, until it reaches the middle thwart, where it is passed over another pulley, i^x, one for each chain or wire, and connected to a weight, *l*, having two eyes or holes, one for each rope or chain. This weight is conveniently guided between two uprights screwed to the thwart to prevent the weight from swinging about in a seaway. If desired, the weight has a rod, l^2, passing through a hole in the thwart and provided at the top with an eye for a lanyard, l^3, to permit of pulling up the weight when hooking on the falls.

Oil Fuel for Steamships

B. C. Pearson, chairman of the Eagle Oil Transport Company, Ltd., of Great Britain, recently reported to his stockholders about the utilization of oil on its ships as follows:

The question of motive power of the new vessels had been very carefully considered by the board and the company's technical staff in conjunction with the various builders, with the resulting decision that turbines and oil-fired boilers were being installed. There could, he thought, be no doubt that at no distant date internal combustion engines of the desired type would be established practice for marine purposes. Internal combustion engines, however, had not yet proved of equal reliability to steam, and in any event the large size of their new vessels and the horsepower correspondingly required precluded the use of the Diesel engine in the present case.

Two years ago the then chairman gave the approximate comparison of a ton of liquid fuel used in Diesel engines as performing four times the work of an equal weight of coal used for steam-raising. Although their new vessels would not reach this position of relative economy in fuel consumption, the directors believed that in installing the most efficient steam motive power—namely, the latest type of high speed turbines, geared down to the most efficient propeller speed, and by repeating their existing practice of oil-firing their boilers—they were making an appreciable step forward in marine engineering practice as applied to large cargo vessels, and should, in fact, be reaching an eminently satisfactory half-way house.

Internal-Combustion Engine Lubrication and Lubricants*

BY P. H. CONRADSON

THE main consideration in the selection of oil for the various classes of service are not well understood. Too much weight is given to vague inferences as to the relative value of viscosity and flash point alone, without taking into consideration many other important factors; and while it is true that some few engine manufacturers have conducted exhaustive investigations to determine just what particular grade of oil should be used by their engines, the greater part of the work of developing suitable lubricants for the various combustion engines has been done by the refiners and dealers of oil.

While the determination of viscosity—that is, body or consistency at a given temperature—is one of the vital tests usually applied to lubricating oil for internal-combustion engines, it is of importance only when the user of the oil is thoroughly familiar with the characteristics of the different crude oils of which it is made and is sure that the mechanical condition calls for the use of an oil having the stated viscosity. Two oils of the same viscosity, made from different crudes, may behave quite differently under identical working conditions.

Viscosity Tests and Temperature

The determination of viscosity of an oil, to be of the greatest value, should be made not only at the lower temperatures, but also as near the temperature of its use as consistent. On the one hand, an oil of low viscosity might be preferable, since it absorbs less power than a thicker oil in the separation of metallic surfaces moving at a high velocity over each other; in other words, high viscosity means a high internal friction. On the other hand, if the oil is too thin it is more easily displaced from between the bearing surfaces, and a heavier oil might then be preferable, as the engine will be more flexible at low speed, owing to better seal and less leakage. Therefore, due consideration must be given to the influence of temperature on the viscosity, and to the necessity of selecting the proper grade for the service required.

Owing to the comparatively high temperature under service conditions, there generally is no trouble from the oil being too thick when once in use. However, an oil must possess a degree of fluidity at ordinary temperatures —which are influenced by climatic conditions—suited to the method of supplying the oil to the working parts, so as to obtain proper lubrication at the start. A lubricating system with exposed pipes, especially a force-feed system, should have a lower "cold-test" oil to meet these conditions; while in a system where the oil is carried in a pump integral with the engine crank case and where the supply pipes are not exposed, all parts of the system quickly become sufficiently heated to promote a positive circulation and an oil with a higher "cold test" may be used with good results.

The flash point of an oil is of no particular value after the oil has once entered the explosion chamber, where the temperature is considerably higher than that of the

* From a paper before the American Society for Testing Materials, Atlantic City, June, 1918.

flash point. Nevertheless, it is important to use an oil of sufficiently high flash point for reasons of economy if for no other, to resist the vaporization which takes place when the oil comes in contact with the highly heated surface of the piston head, and other parts below the piston. In considering this it is well to remember that with many oils there is little connection between the evaporation (heat) loss and the flash point. Investigation has shown that while two oils may have the same flash points, the percentages of evaporation loss at a given temperature may be quite different. Generally speaking, however, the evaporation loss is greater in oils having a low flash point.

Obviously, that oil which, when subjected to an evaporation test at a certain temperature, loses the least and leaves a residue that has been broken up or altered in character as little as possible by the heat treatment is the most desirable for lubrication of internal-combustion engines. Therefore, the evaporation and oxidation tests offer a promising means of examining the oil and noting the changes that develop in different oils under similar conditions of treatment.

Oil consists principally or entirely of compounds of carbon and hydrogen. At high temperatures these hydrocarbons decompose, forming volatile combustible gases and heavy hydrocarbons, or carbonaceous matter, and free carbon. This breaking up may be due to improper methods of refining or to the nature of the crude oil. Only the most highly refined and filtered oils should be recommended to meet these conditions.

Much has been written about the carbon residue of the oils for this class of service. The carbon in all oils can be fixed by driving off the oil vapors (without addition of air), leaving a layer of carbon deposit, called carbon residue. The condition of the carbon formation in the cylinder is somewhat different from that found in the carbon-residue test, due to the fact that in the cylinder the oil is spread out in a thin film on hot metal surfaces, and exposed to the burning gases of the explosion, which may carry widely varying amounts of oxygen to combine with the oil. Also, the amount of carbon deposited in the cylinders is governed by the amount of oil reaching the explosion chamber, and may depend to a great extent upon the mechanical fit of the pistons, piston rings and cylinders. It is expected that some oil will find its way into the combustion space, but it is assumed that it will be burned up without depositing an excessive amount of carbon on the cylinder walls and pistons.

One of the most injurious effects of improper lubrication is the formation of this carbon deposit around and under the piston rings. Such a deposit soon renders the spring rings inoperative; they become partly fastened in their grooves, and in this condition form one of the most prolific causes of cut and scored cylinders and broken piston rings. One of the causes of this trouble may be the use of too much oil. From the result of much investigation along this line it has been conclusively demonstrated that an oil with the lowest carbon residue, other things being equal, will leave behind the lowest carbon deposit in the explosion chamber.

In connection with the physical characteristics of the carbon deposit it is of importance to select a lubricant which leaves a loose and flaky or soft carbon deposit, easily removed, rather than one leaving a dense, hard deposit difficult to remove.

Assembling and Regulating Ship's Structure

Rigid Supervision and Strict Check and Recheck System Necessary to Eliminate Errors in Assembling Fabricated Ships

BY T. L. COHEE*

In view of the gigantic programme of turning out ships for the government, so expeditiously as to combat the submarine menace and to provide a merchant marine in keeping with the needs of the United States, it may be worth while to contribute a few practical notes on the assembling and regulating of ship's structure, since the time for actual building is present and the "on paper" period of the game is past. It is well to have spirit and enthusiasm, but the programme should not be treated as a task similar to the manufacturing of a certain number of drop forgings, or to the molding out of so many slabs of concrete, or the digging of so many cubic yards of earth. Nor is it exactly similar to the erection of large structural bridges or buildings.

The riveting problem, the most continuously repeated operation in the construction of ships, is not merely a plain example in arithmetic in which so many rivets are to be driven in a ship. Along that line of reasoning, one gang would be capable of driving so many rivets in a day, and when multiplied by one hundred rivet gangs, so many more could be driven in one day. Among the mass of multitudinous details involved, however, the preparation of the hole to receive the rivet must be noted. This work requires a great many other skilled men.

In the assembling and regulating of a large ship of thousands of units, even though hundreds of said units may be apparently alike, that factor—the human element of error—steps in and must be considered. When it is a fact that the possibility of error begins in the drawing room, thence progresses into the loft, in the template in all the various processes of fabrication, the structure becomes one great flexible mass that must be regulated, checked and rechecked.

The writer's experience dates back to the period of the "lifting" or templating of one structural member, erection, and then the repetition of the process throughout to completion. I have seen the gradual improvement of the methods employed in shipbuilding, up to the laying off and erection of 90 percent of the whole ship from mold loft template. I have seen the latter condition duplicated, that is, several ships built from one set of templates. Choosing a set of three vessels as an example, in number one the results in the assembly and regulating may be all that could be desired; in the case of number two, an ever-increasing shrinkage occurs in one place or a shortening of members at other places; while in number three the

* Foreman shipfitter (new construction), Hull Division, League Island Navy Yard, Philadelphia, Pa.

riveting of members follows the assembly so closely that gain or stretch becomes pronounced. As a result, the interlocking members are consigned to scrap and conditions rectified to suit with new materials. These conditions show that if a vessel were put together, all parts properly fitted piece by piece, and then disassembled for the purpose of using the parts as standard templates for the duplication of a number of vessels to be constructed later, the possibility of human error would bring about conditions similar to those noted above. Therefore, to minimize the possibility of error in the assembly of the fabricated ship, where hundreds of units are fabricated at different shops and later in assembly must member with one another, the strictest sort of check, recheck and inspection is necessary. This rigid and effective supervision must also follow into the period of assembly at the yard.

Process of Assembling and Regulating Ship's Structure

In assembling and regulating a ship's structure, expansion and contraction must be eradicated. Then, if we are informed that 25 percent of the riveting will be done in the ship fabrication, a great deal of that chance for "come and go" will have been taken up, leaving little chance at the yard for rectifying these faults.

The writer has found that when assembling a constant check must be maintained on structure, and the work regulated to proper position in advance of the erection of the next member. In other words, when regulating a member, one is at the same time preparing to unite it with the structure to follow.

It is customary for the riggers (at some yards called "erectors") and the regulator, who is a shipfitter, to coordinate. The rigger hoists the work, places it in position and secures it with just enough bolts to hold it in place. Here his function ends. The shipfitter then regulates it to its true position—or possibly its approximate position, depending on the installation of the next member—after securing it with possibly a half dozen bolts. A gang of bolters follow and place enough bolts in the work to bring the members into intimate contact, ready for the reaming and recountersinking of holes, the reaming and bolting gangs, of course, working in conjunction.

When the work is reamed the bolters clean out the foreign matter that may have collected between the faying surfaces, and, at the direction of the foreman calker, insert stopwaters where necessary. I may add that when the point is reached where insertion of stopwaters takes place, skilled bolters readily know where and how to apply these; but when only semi-skilled workman are employed, this function is best directed by the foreman calker, who is eventually held responsible for getting the structure water or oil tight, as the case may be. When the structure is securely bolted and the former bolt holes reamed and recountersunk, the work is then ready for riveting.

Regulating Decks

In regulating a deck, assuming that the beams are in position, the first strake of plating on the center line is regulated in position and checked to length. This operation ties the beams and regulates the side of the ship to its proper transverse position. Very often better results may be obtained by regulating the side of ship with the stringer plate, since this is heavier and can stand the heavy drifting required in adjusting the beams to their "in" or "out" position. The center line strake of plating should be in position as soon as possible, in order to place the stanchions in position ready to bear the beams of the deck above. If the stanchions are not ready, temporary shores should be used. The other strakes of plating can then be placed in position, one strake at a time. Each should be temporarily regulated pending the installation of all the strakes. After all are installed, it is better practice to begin regulating amidship, usually at a bulkhead that has been "horned," that is, adjusted perpendicular to the fore and aft center line of ship, work forward and aft, as well as athwartship, checking at the next bulkhead reached.

In regulating a deck, one side often runs ahead or astern of the side opposite; one strake of plating will show a tendency to run away from the adjoining strake. To overcome this defect some of the yards have adopted the rule of omitting one strake of plating port and starboard and templating them from ship. However, if it is possible, lay off the whole deck structure from mold loft template, provided the loft has sufficient floor space to lay down the whole deck at once. Since laying the deck down in several sections intensifies the chances of irregular work, from the standpoint of centralizing the work in one department, it is better to lay off the complete deck. Templating from ship causes a hitch or delay just when continuity of erection is expected. Possibly a bulkhead is to be installed on the deck, or there may be the beginning of a fore and aft bulkhead on this omitted strake. In these cases the shipfitter and loft would not be working together.

Assembling the Keel

It is very important that extraordinary care should be taken in the assembling of the outer keel, the inner keel (if any) and the vertical keel. Time spent in careful checking of this structure means time saved in assembling the members to follow. If the keel blocks are ready for installation of the keel it is better practice to assemble the keel on the blocks, rather than to assemble it in the shop in sections, since, at most, only 50 percent of the work can be shop riveted on account of the overlapping or break in angle butts. The trouble encountered in assembling on the blocks at the junctions of the sections more than offsets the gain in shop riveting.

Assembling Bottom Shells, Side Shells and Bulkheads

I have seen eighteen or twenty plates at a stretch placed in position on the garboard (lap butted and lap edged with one-inch rivet holes). These matched up nicely with the keel lap, and the holes at each butt lapped fairly well. Apparently this would be considered well regulated and would be pronounced good work. Then when the "B" strake of plating is put in position it is seen that the "A" or garboard strake has gained probably an inch in length. Readjustment of the garboard strake follows. The difference in the holes is not then apparent to the eye.

It is customary at some yards to nick the position of the sheet edges on the heels of the frames from the mold loft template as an aid in regulating the plates. The plate edges are not, however, at all times sheared accurately enough for this to be a dependable guide. Besides, the loftsmen are accustomed to place the sight edges of the plating on template, whereas, when regulating shell plates, the edge of the plate next to the frame is the one that is needed.

A common fault encountered in regulating the side shell is the tendency of the plating to lose in height, due to the weight of plating on the bolts and the size of the holes, which are a sixteenth of an inch larger than the bolts.

The conditions noted in the assembly of bottom shell

are also common in the assembly of large bulkheads when assembled on the ground. They should be checked both for height and breadth. It is best to assemble a bulkhead on the ground, even though it may have to be separated and hoisted into position on ship in sections which suit capacity of crane.

Water Lines on Bulkheads

As a check in assembly, it is good practice to have at least one water line stamped on the plate from the template when the plates are in horizontal strakes. When in vertical strakes, at least two lines should be stamped on the plate, one at the top and one at the bottom. Corresponding water lines should be stamped on the heels of the stiffeners.

These water lines are not only convenient in getting accurate assembly but are very beneficial for later work, such as the centering of shaft heights for pumps, motors and various auxiliary foundations that may be subsequently erected by heights given from base, which is generally not accessible.

It is, of course, a level line and is frequently needed in the construction of the ship even after she is in the water. The water lines are center punched on the plate from the template in even feet and are then enclosed by a paint mark, so that they can be plainly seen. A water line on the floors is very essential to accurate assembly, as well as being of great benefit to the ship carpenter in keeping the ship fair, especially with a curving inner bottom.

At some yards a datum line is established conveniently below the keel by the use of a transit, and spots from the body plan are given to the sight edges of shell plates at frequent intervals. By these means the ship carpenter keeps the ship fair. This datum line is marked on ordinary uprights fastened to the ground sleeper at certain intervals. When a spot is desired at any point between uprights, a line is stretched from one upright to another. This method of keeping the ship fair is probably satisfactory when the foundation is of concrete, but when it is constructed of ordinary piling the datum line has to be frequently checked as the ship takes on weight and settles.

Angle Connections

In attempting to make templates symmetrically for longitudinal connections to floor, and similar operations, the human element of error again intrudes. In consequence, one flange of the angle will vary slightly from the other, just enough to cause trouble in the assembly. To overcome this fault, it is better to make the difference in flanges pronounced and easily seen, so that the angle will have only one definite relation to the connecting part. Another fault arises when making the clip symmetrical—holes spaced alike in both flanges. The riveting becomes more difficult when the holes are opposite and the sectional area of the shape is in consequence considerably reduced.

This carries the reader to mold loft methods, a subject which may be touched on later.

Control of Hull Construction of 5,000-Ton Deadweight Fabricated Steel Vessel

System Employed at Yard Where Straight Work was Produced at Outside Shops and Furnaced Work Turned Out at Yard

BY FABRICATOR

PROPER control of plans, material orders, material deliveries and the fabricating shop is necessary to obtain the advantages offered by the design of the standard fabricated steel ship. In addition, this control develops a high type of organization, both in the yard and in the office, and eliminates friction between the two, as well as establishing full confidence outside.

As preliminary control is arbitrary, it is necessarily simple and direct, and its effectiveness depends upon the executive ability behind it. It may be considered the office policy of the shipyard in that it makes provision only for the completion of the plans prior to their need, ordering of material in time to insure satisfactory delivery of raw material to the yard and fabricator, delivery of fabricated items and machinery and equipment.

The yard is "controlled" by the fact that it will work on what it receives, though it is kept fully posted on material ordered and moving. As this method has been proved satisfactory in a yard where all of the straight work was produced by a distant fabricator, including oiltight and watertight work, and the bent and furnaced work turned out at the yard, it will be given in detail, using approximate values—relatively correct.

Nine 5,000-ton deadweight Ferris type steel cargo vessels were to be built; three ways were available, and 90-day periods were fixed, arbitrarily, for completion of each lot of three vessels, so as to complete the nine vessels 270 days after laying the keel. Keels were laid on each way at the same time to start rivalry between the ways.

From previous records it was assumed that approximately 1,911 tons of steel bars, plates and shapes would be required for each vessel. The hull structure was classified to meet contract payments, and the tonnage spread as follows:

Item	Includes	Weight, Percent
Keel	Flat plate keel and center vertical keelson, both complete.	2.6
Shell plating (bottom)	Garboard to bilge strakes, inclusive and complete.	9.2
Floors	All floors, shell and tank top liners and side keelsons, complete.	12.8
Tank top	All tank top plating, machinery foundations, shaft alley flat and foundations, cover plates and miscellaneous flats, complete.	12.1
Bulkheads	All bulkheads, tank top to second and upper decks, deep tank and peaks' swash - bulkheads, complete.	6.5

FORM ES—ERECTION SCHEDULE
FOR NINE 5,000-TON DEADWEIGHT STEEL CARGO VESSELS.

January 10, 1918.

		Estimated Weight, Tons.	Days to Erect.	Completion Dates.		
				Hulls, 87, 88, 89	Hulls, 90, 91, 92.	Hulls, 93, 94, 95.
Keel blocks laid	K	......	1.0	4/9	6/10	8/12
Keel	1	47.30	1.3	4/10	6/11	8/13
Bottom shell (A-E)	2	176.00	4.9	4/15	6/16	8/18
Stem	3	......	....	4/15	6/16	8/18
Stern frame	4	....	....	4/15	6/16	8/18
Floors	5	244.70	6.8	4/22	6/25	8/25
Tank top	6	230.10	6.4	4/28	7/1	9/11
Bulkheads	7	123.10	3.3	5/2	7/4	9/5
Frames	8	242.00	6.7	5/9	7/11	9/12
Deck beams	9	118.60	3.3	5/12	7/14	9/15
Shell plating	10	307.50	8.5	5/22	7/23	9/24
Decks	11	195.90	5.5	5/26	7/28	9/30
Houses	12	226.30	6.3	6/1	8/3	10/6
Preparation	P	......	7.0	6/8	8/10	10/13
Launch	L	......	1.0	6/9	8/11	10/14
Totals	....	1,911.50	62.0			

Lay keels of hulls 87, 88, 89 on April 9. Launch hulls 87, 88, 89 on June 9. (Allow seven days for preparation.) 53 working days from April 9. 1,911 tons to erect each ship for period 36 tons a day each ship for period.
Fabricator must ship six days prior to our requirements.

FORM SRS—STEEL REQUISITION SCHEDULE
FOR NINE 5,000-TON DEADWEIGHT STEEL CARGO VESSELS.

January 10, 1918.

Item.	Seq.	Req. Due.	P. O. Placed.	Tons of Steel Ordered.		
				Plates.	Shapes.	Total.
Keel	1	Rush	1/15	39.8	7.5	47.3
Bottom shell	2	"	1/15	176.0	....	176.0
Floors	3	"	1/15	143.2	101.5	244.7
Tank top	4	"	1/14	179.3	50.8	230.1
Bulkhead	5	1/10	1/12	62.9	60.2	123.1
Frames	6	1/10	1/12	64.5	177.5	242.0
Deck beams	7	1/15	1/17	9.5	109.1	118.6
Shell plating	8	1/20	1/23	307.5	....	307.5
Decks	9	1/23	1/30	195.9	11.0	184.9
Houses	10	1/30	2/5	168.5	57.8	226.3
Stem	11	....	2/15	......	......	5.5
Stern frame	12	....	2/15	......	......	9.7
Rivets	13	....	1/12	......	......	200.0
....		....	2/10	......	......	60.0

Purchase Orders to cover nine vessels placed simultaneously with deliveries specified as shown on Schedules YS and FS.

FORM FS—FABRICATOR'S ERECTION SCHEDULE
FOR NINE 5,000-TON DEADWEIGHT STEEL CARGO VESSELS.

		Estimated Weight 1 Hull.	Estimat'd Weight 1 Lot.	Days to Fabricator.	Lot 1.			Lot 2.			Lot 3.		
					Must Ship.	Due at Fabricator.	Mill Ships.	Must Ship.	Due at Fabricator.	Mill Ships.	Must Ship.	Due at Fabricator.	Mill Ships.
Keel	1	42.1	126.3	1.8	4/2	3/25	2/25	6/3	5/30	4/30	8/5	7/31	6/30
Bottom shell	2	87.3	261.9	3.3	4/5	4/1	3/1	6/6	6/1	5/1	8/8	8/2	7/2
Floors	3	215.2	645.6	8.2	4/14	4/5	3/5	6/14	6/9	5/9	8/17	8/10	7/10
Tank top	4	165.7	497.1	6.2	4/20	4/14	3/14	6/21	6/15	5/15	8/23	8/16	7/16
Bulkheads	5	105.6	316.8	3.9	4/24	4/20	3/20	6/25	6/19	5/19	8/27	8/20	7/20
Frames	6	102.4	307.2	3.8	4/28	4/24	3/24	6/29	6/23	5/23	8/31	8/24	7/24
Deck beams	7	107.6	322.8	4.0	5/2	4/28	3/28	7/3	6/27	5/27	9/4	8/28	7/28
Shell plating	8	127.7	383.1	4.8	5/7	5/2	4/2	7/8	7/1	6/1	9/9	8/31	7/31
Decks	9	170.7	512.1	6.4	5/15	5/7	4/7	7/14	7/7	6/7	9/15	9/6	8/6
Houses	10	208.3	624.9	7.8	5/21	5/13	4/13	7/22	7/15	6/15	9/21	9/14	8/14
Totals	....	1332.6	3997.8	50.0									

Data—1333 tons to fabricate for each hull. Material put through in three lots of three hulls each (3999 tons). 50 days allowed for each lot. 80 tons to fabricate daily. Mills to ship 30 days prior to requirements. Lot 1 covers hulls 87, 88, 89. Lot 2 covers hulls 90, 91, 92. Lot 3 covers hulls 93, 94, 95.

FORM YS—YARD SHOP SCHEDULE
FOR NINE 5,000-TON DEADWEIGHT STEEL CARGO VESSELS.

January 10, 1918.

		Estimated Weight 1 Hull.	Estimated Weight 1 Lot.	Days to Fabricator.	Lot 1.		Lot 2.		Lot 3.	
					Must Comp.	Mill Ships.	Must Complete.	Mill Ships.	Must Complete.	Mill Ships.
Keel	1	5.2	15.6	.5	4/7	3/7	6/8	5/8	8/9	7/9
Bottom shell	2	88.7	266.1	7.7	4/15	3/15	6/16	5/16	8/17	7/17
Floors	3	29.5	88.5	2.6	4/18	3/18	6/19	5/19	8/20	7/20
Tank top	4	64.4	193.2	5.5	4/23	3/23	6/24	5/24	8/25	7/25
Bulkheads	5	17.5	52.5	1.6	4/25	3/25	6/26	5/26	8/27	7/27
Frames	6	139.6	418.8	11.9	5/6	4/6	7/7	6/7	9/8	8/8
Deck beams	7	11.0	33.0	1.0	5/7	4/7	7/8	6/8	9/9	8/9
Shell plating	8	179.8	539.4	15.4	5/22	4/22	7/23	6/23	9/24	8/24
Decks	9	25.2	75.6	2.2	5/24	4/24	7/25	6/25	9/26	8/26
Houses	10	18.0	54.0	1.6	5/26	4/26	7/27	6/27	9/28	8/28
Totals	....	578.9	1736.7	50.0	....	....	....	....	....	....

Data—579 tons to fabricate for each hull. Material put through in three lots of three hulls each (1737 tons). 50 days allowed for each lot. 35 tons to fabricate daily. Mills to ship 30 days prior to requirements. Lot 1 covers hulls 87, 88, 89. Lot 2 covers hulls 90, 91, 92. Lot 3 covers hulls 93, 94, 95. Shop must complete two days prior to erection gang requirements.

Frames	All frames attached to tank top and to floors in peaks and second deck, all pillars and stringers below upper and second decks, complete.	12.6
Deck beams	All second deck and upper deck beams and girders and gussets, complete.	6.2
Shell plating	Above bilge to and including sheer strake.	16.0
Decks	All second and upper deck plating, all deck foundations, hatch fittings.	10.3
Houses	All frames, stanchions, bulkheads, beams, deck and shell plating above upper deck; all casings and escape tunnel, complete.	11.7

The first three vessels were to be launched 60 days after the keels were laid and 7 days were allowed for preparation and final inspection previous to launching, leaving 53 days for the erection of 1,911 tons of steel.

An Erection Schedule (Form ES) was developed and used as a basis for the Fabricator's Schedule (Form FS) and Yard Schedule (Form YS), Steel Requisition Schedule (SRS) and Drawing Room Schedule (Form DRS).

The tonnage handled by the fabricator for each vessel was approximately 1,332 tons, spread as follows:

Item	Weight, Percent	Weight, Tons
Keel	3.1	42.1
Bottom plating (strake A to E)	6.5	87.3
Floors	16.2	215.2
Tank top	12.3	165.7
Bulkheads	8.0	105.6
Frames	7.8	102.4
Deck beams and girders	8.0	107.6
Shell plating	9.6	127.7
Decks	13.0	170.7
Houses	15.5	208.3
Total	100.0	1332.6

From this the Fabricator's Schedule (Form FS) was developed.

All car movements were carefully followed, but 30 days were allowed for the railroad to deliver the steel to the fabricator and yard from the steel mill, and 6 days to deliver the fabricated items to the yard from the fabricator. This is quite necessary to cover delays due to bad order cars and bunching of cars at destination, which, though very undesirable, cannot be advantageously avoided.

The Yard Schedule (Form YS) was devised to cover the output of the yard shop, and with the Yard Erection Schedule and Fabricator's Schedule covered our steel control.

A classification of the hull to differentiate the work done by the fabricator from that done by the yard was made, dividing the vessel into five transverse sections:

Section 1.—Covered all items from the stem aft to the collision bulkhead.

Section 2.—Covered all items from the collision bulkhead to the frame at 42.

Section 3.—Covered all items in th eparallel middle body from frame at 42 to frame at 93.

Section 4.—Covered all items from frame at 93 to bulkhead at 128.

Section 5.—Covered all items aft of frame at 128.

Practically all items of Sections 1 and 5 were fabricated at the yard; the furnaced items of Sections 2 and 4 were fabricated at the yard, and the balance of the items at the fabricators; all of Section 3 was done at the fabricators.

This gave us a definite basis for our Steel Requisition and Drawing Room Schedules.

It was intended to have requisitions for steel issued about 10 weeks before the mill delivery specified. This would allow four weeks for the allocation and the balance for the mill to schedule and produce.

Requisitions for the inner bottom material for the first three boats had to be rushed to the mills, but no confusion or delay was caused, as it was known definitely just what was wanted and when it was wanted.

Material schedules covering the items required for one ship were typed on lightweight, transparent paper—carbon backed to be blue-printed. Separate requisitions and purchase orders were made for each hull and the necessary material schedules blue-printed. The requisition and purchase orders bore all of the delivery dates and necessary information for the hull which it covered. Separating the hulls in this way gave very close and accurate control.

This method carried one shipyard over the high spots very satisfactorily and should at least be suggestive.

(*To be continued.*)

Steam Preferred

A man had the running of a heavy oil engine in a boat plying between two points. He also had a steam license and applied for a position on a steamboat. When asked why he wished to leave the job of handling the oil motor, he said: "Oh, the engine ran all right and we made our trips, but I got tired of feeling as if I was a tight-rope walker."

"What do you mean?"

"Well, you see, a tight-rope walker is pretty sure to walk his wire without falling off, but he is mighty glad when he gets across, and that is just the way I felt in making my trips—I was pretty sure to get there, but was just tickled to death when I did."

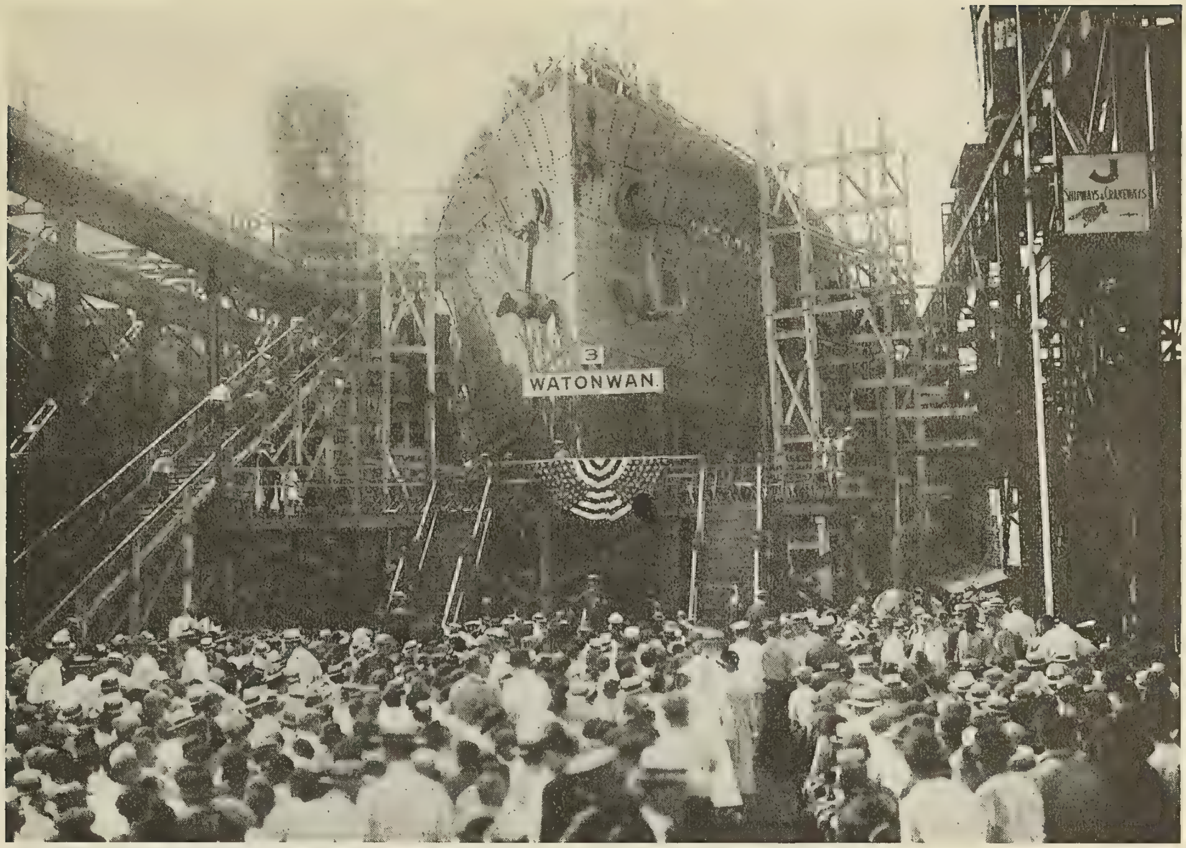
Now just watch and see if there are not a lot of men who will say that the story is true.

First Launching at Merchant Shipbuilding Yard, Harriman, Pa.

The ceremonies attendant upon the launching of the *Watonwan*, the first ship turned out by the Merchant Shipbuilding Corporation at Harriman, Pa., were unique among the launching festivities of the country in that they preceded the actual launching by some ten days. August 3 was the date set for the affair, and on that occasion over thirty thousand people were gathered at the Merchant yard to see the big carrier go over, but for some reason the vessel stuck on the ways and a postponement was necessary.

On August 14, however, the ship did go over, and the manner in which the launching was carried out won the admiration of men who have devoted their entire lives to the building of ships. At this time there were no special ceremonies except the christening, which was performed by Mrs. W. Averell Harriman, the wife of the chairman of the board of directors of the company.

The *Watonwan* is the first of a fleet of sixty vessels which is to be built at the Merchant yard, sixteen of which have been promised for delivery by January 1, 1919. General Manager D. D. Smith and his associates at the Harriman plant are bending every effort to fulfill this "sixteen-ship" promise that Mr. Harriman made to Director General Schwab some time ago, and there is every indication



S. S. *Watonwan* Ready for Launching at Merchant Shipbuilding Corporation Yard

at present that they will be successful, as the second launching is expected in the very near future.

The *Watonwan* is an 8,800-ton deadweight steel cargo carrier of the same type as the other vessels that are now under construction at the Merchant yard. The length of the load waterline is 400 feet 8 inches, while the other principal dimensions are as follows: Length over all, 417 feet 9½ inches; beam, 54 feet; depth to upper deck, 32 feet 10 inches; mean light draft, about 8 feet; load draft, about 25 feet; displacement at load draft, 12,214 tons; cargo capacity, about 7,400 tons.

The hull is designed upon the improved deep channel frame principle without stringers or other obstructions in the holds. Two rows of longitudinal deck girders are fitted 21 feet 6 inches each side of the center line. Pillars of heavy built-up columns are located along the center line of the ship, the load being transferred to same by transverse girders. A cellular double bottom extends all fore and aft, to be used for fuel oil or water ballast. Six transverse watertight bulkheads divide the hull into seven watertight compartments, including five cargo holds, the machinery space and peak tanks.

Propulsion is by a geared turbine of 2,500 shaft horsepower, driving a single propeller shaft at a speed of ninety revolutions per minute. Steam is furnished at a working pressure of two hundred pounds per square inch by watertube boilers.

Mrs. Harriman Christening the *Watonwan*

The *Watonwan* Afloat

Letters from Marine Engineers

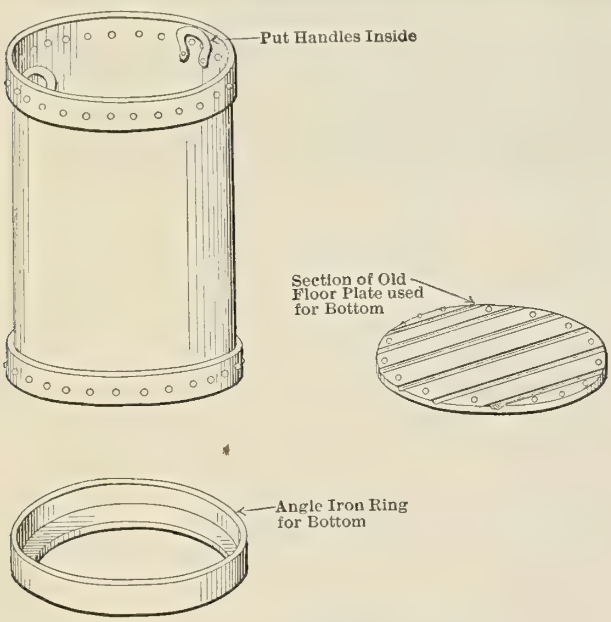
Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Durable Coal Bucket

While on a recent trip I stopped in at a small shop which was employed on some marine contracts. One of their jobs was that of making a thousand ship's coal buckets. Now this shop had always made small repairs and done overhaul work on marine vessels. One of their regular jobs also was that of refitting and renewing engine and boiler room floor plates. Consequently, they had on hand a large quantity of old floor plating.

When this order for coal buckets came along the foreman managed to save considerable steel plate by making



Details of Construction of Bucket

the bottom plate of the buckets out of these worn, smooth, misfit floor plates. Conservation of steel plate is a big thing, and such ideas are to be commended.

The details of these buckets are shown in the sketch. The placing of the handles inside saves them from being banged and broken, as they are when exposed on the outside.

C. H. WILLEY.

Official Uniforms for the Merchant Service

In a recent communication of mine, reference was made to the fact that men in the British merchant service are to have an official uniform.

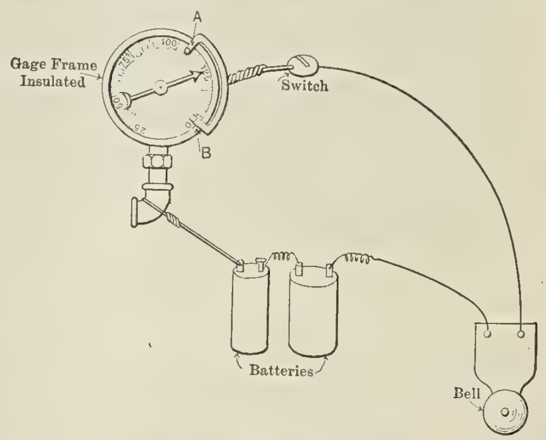
This is, of course, as it should be. Up to now there has been no official recognition of the mercantile marine; the commander of the *Lusitania,* for example, was legally master mariner and not entitled to the prefix "captain," nor had his gold braid any worth off his own ship.

The new uniforms just sanctioned will be confined to holders of Board of Trade certificates, either deck or engineer, and to surgeons, pursers and apprentices, as well as uncertificated junior officers qualifying for a certificate. Certain details have been fixed; the cap is to bear a gold admiralty anchor and naval crown surrounded by oak leaves, but the executive loop on jacket sleeve is withheld.

London. A. L. HAAS.

Gage Alarm

This is a rather crude but no less useful manner in which an alarm signal for high and low pressure was made on an air compressor tank gage. The outside of the frame of the gage was insulated by a band of rubber



High and Low Pressure Alarm

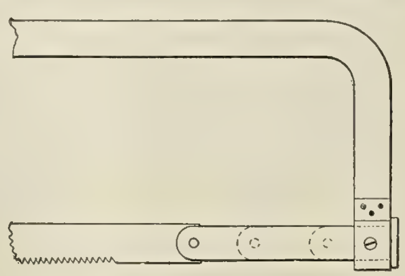
packing. The sketch roughly shows the scheme of wiring.

Perhaps the idea can be improved upon. However, this rough device serves its purpose at the place it was installed.

ENGINEER.

Arrangement of Hack Saw Handle to Hold Different Length Blades

In order to be sure of having a handle that will fit various lengths of hack saw blades, such as 8 inches, 10 inches and 12 inches, it is often necessary for the engineer



Attachment of Hack Saw to Handle

to carry in stock several sizes of handles which are cumbersome and take up considerable space. An arrangement for adopting one large handle to take the different size blades by merely changing one part is shown in attached sketch.

The end of the handle to which the outer end of the

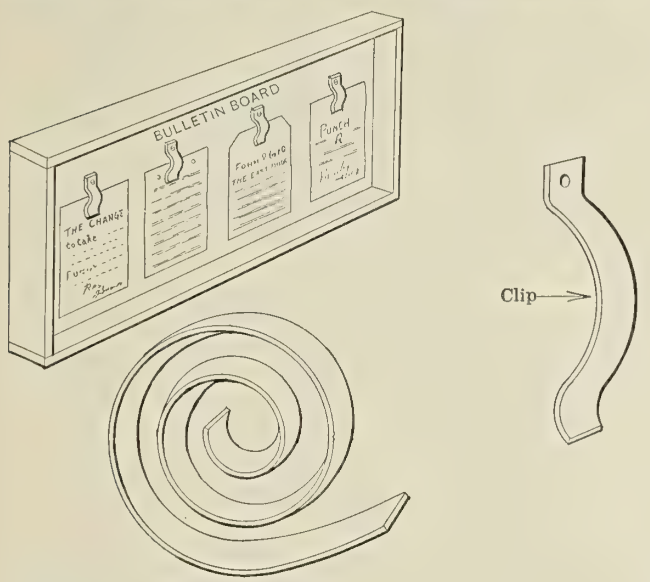
blade is attached is made removable, being held in place by a small screw. If a short blade is used, the long holder-end is inserted as shown in the sketch. If a medium length blade is used, say 10 inches, the long holder-end is removed and is replaced by a shorter end to accommodate the longer blade. In this way the single handle with the interchangeable length of holder-ends serves the same purpose as carrying three complete saw handles in stock.

Philadelphia, Pa. W. A. Lailer.

Bulletin Board Clips

The sketch shows a rather handy kink for the shop bulletin board—that of making spring clips to hold the various notices and bulletins.

The clips are quickly and easily made from an old clock spring. The holes in the clips are punched in with a



Clips Made From Clock Spring

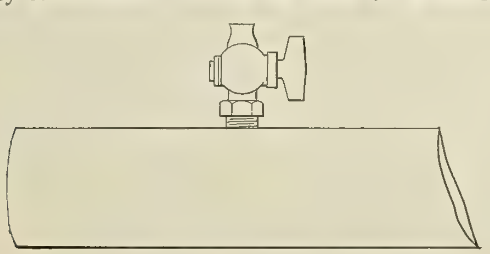
steel drift. Lay the section of spring on a hardwood block (end grain) and hit the punch or drift a sharp heavy blow. This punches a clean hole.

The clips are secured to the board with a small wood screw. For wide notices two clips work best.

Machinist.

Method of Detecting Leaky Traps

Where high pressure steam traps discharge into the open it is easy to maintain a watch on them to detect leakage.



Petcock Installed in Discharge Line of Trap

Where the traps discharge into a closed system the traps are liable to leak and waste steam for considerable periods without detection unless some means of checking them is used.

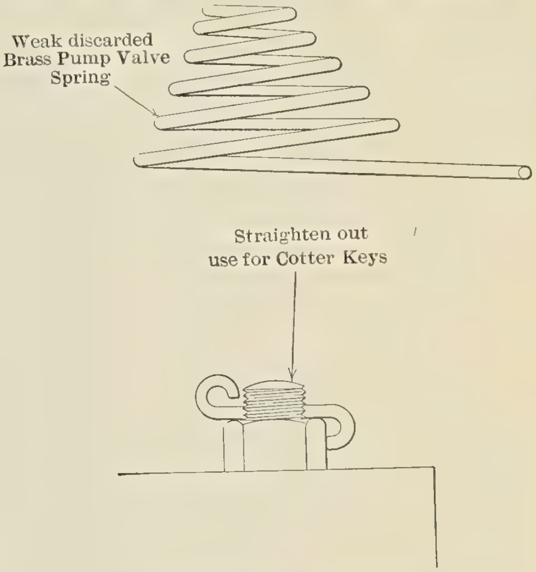
A simple tell-tale arrangement to show up excessive steam leakage past the trap is to install a petcock in the discharge line of the trap. If the cock is opened and only a light vapor rises from it, the operator can be fairly confident that no appreciable leakage is taking place.

On the other hand, if a considerable stream of steam emerges from the opened trycock, it is a sure sign that the trap is blowing and that it needs attention to eliminate the waste.

On Watch.

Use for Old Springs

There are from time to time a lot of worn-out, or rather played-out, weak springs of round brass wire, something like the type shown in the sketches, to be



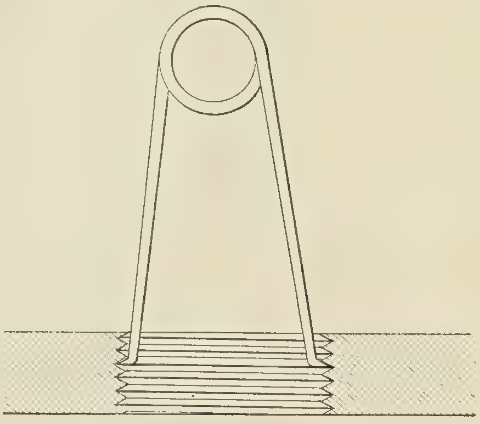
Cotter Key Made from Valve Spring

found in the pump valve chests. When these are taken out don't throw them into the scrap heap. Straighten out the coiled spring and use the wire for such purposes as cotter pins, etc.

Old Scotch.

Handy Tool for Cleaning Out Threads

In doing a considerable amount of piping work the writer has found that considerable time can be saved



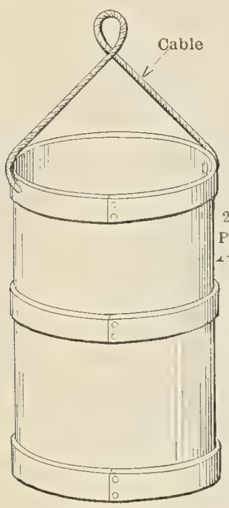
Spring Hook for Cleaning Out Threads

by starting out with clean threads. The time required thoroughly to clean off the threads is more than saved by the ease with which the pipe can then be fitted up.

For cleaning out the threads on the pipe a semi-circular wire brush is very effective in removing dirt, rust or grit. For removing the obstructions from the threads in fitting companion flanges, valves, etc., a simple spring hook as illustrated will be found very effective. L.

Light Weight Ash Bucket

While in dry dock we had the ashes of one live boiler, and those of twelve previously died out boilers, to get rid of in order to carry out the repair work. The regular ship's ash hoist buckets, made of heavy steel, were rugged and cumbersome to handle from the ship to the dock.

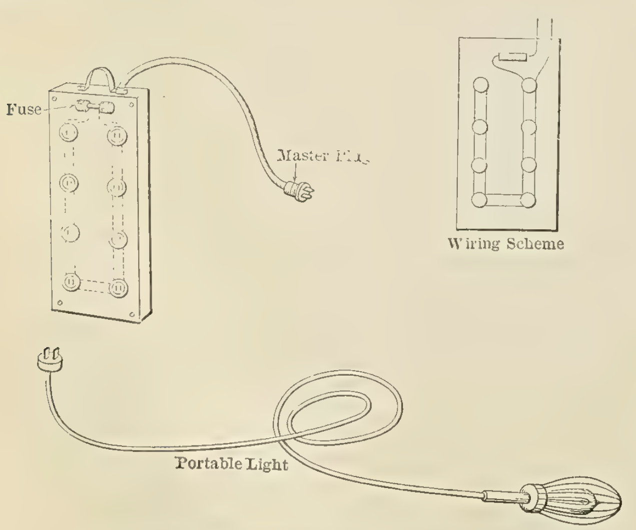


Ash Can Improvised from Empty Paint Drum

To make this work lighter, easier and quicker, the first assistant improvised a lot of light-weight ash buckets, such as shown in the sketches, using empty 20-gallon paint drums, plenty of which are to be had at a dock yard—the kind that ship's bottom paint comes in. The tops were cut out and a piece of cable used as shown. W.

Multiple Connector Board

This simple idea has been used in various ways in many plants and I have wondered why more engineers do not use it.



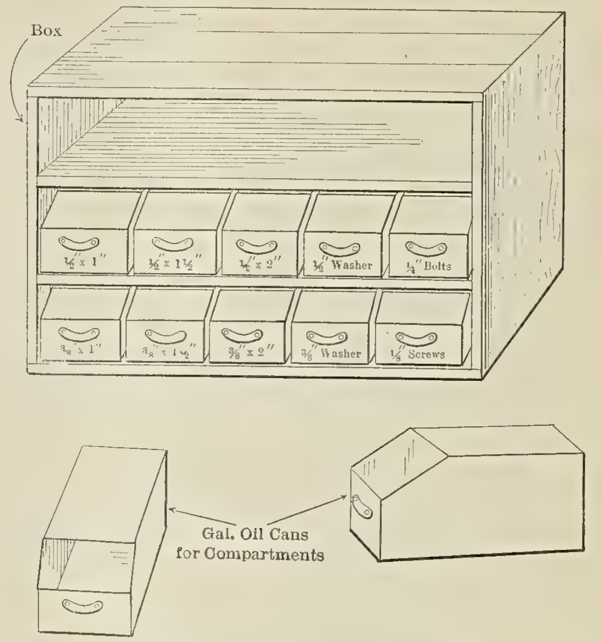
Multiple Plug Board for Portable Lights

Oftentimes it is necessary to use several portable lights such as when cleaning boilers, and perhaps an electric drill or other electric tools. Such a multiple plug board answers the need for plug connectors.

Electrician.

Small Ware Container

A very handy and useful small ware container can be made from empty gallon oil or varnish cans by cutting the tops of the cans on the diagonal, as shown in the sketch.



Improvised Holder for Small Ware

This gives a wide opening, yet does not weaken the strength of the can so that it could be easily bent or pulled out of place. It also permits the contents of the container to be seen at a glance. An old packing box fitted up with a couple of shelves completes the contrivance.

F. W.

Letter Writing

To be able to write a good letter is perhaps one of the best assets that an engineer could acquire. While most of us can handle our actual practical duties aboard ship, when it comes to making up reports, requesting supplies, requisitioning repairs and making written recommendations regarding the need of certain changes, etc., for improving operating conditions, a good majority are up against it, simply because of never having given the subject of letter writing any share of time and study.

True, most ships have their yeomen, or clerks, and some of these are very proficient in paper work, and when an engineer finds one to whom he can dictate a rough draft of what he wants, the yeoman can manage to get out a decent letter. But how much better it is for one to be able to "get off his chest" what he wants to say and do it in a manner that reflects credit to himself and convinces those over him that he is master of his calling.

Perhaps the best way to cultivate the art is to practice until it becomes a habit to write well and interestingly Always make a rough copy of the letter and then read it over to test it; you will soon learn to detect your weak points and be able to correct them. Reading current en-

gineering journals, reports of societies, etc., will provide a means by which you can absorb the necessary engineering terms, phrases, style, composition, etc. You have no need to try and couch your letter in large technical words that sound learned and educated. Write as you would talk—plainly—convincingly—and try to draw the interest of your reader to the subject as deeply as you would were you speaking to him.

Letter writing has the advantage over oral recommendations in that you can lay the matter thoroughly before your superiors in black and white. You have a better chance to weigh your words, and they have a better opportunity to study out what you have said before they come to a decision.

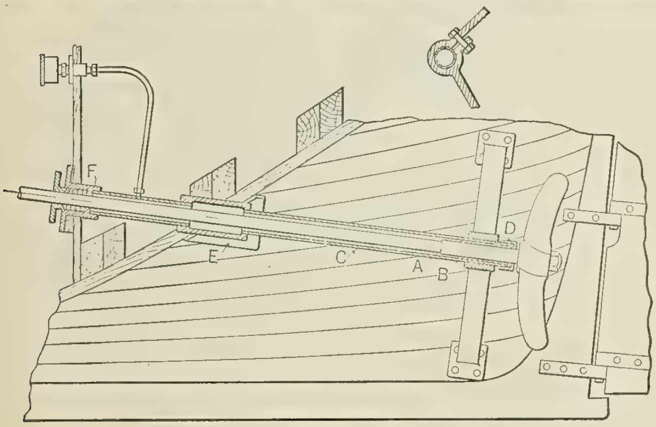
One very successful chief engineer of my acquaintance has developed a most efficient staff by requiring each of his subordinates to make to him quarterly written reports on all subjects of their respective departments.

One percent of their work is paper work, such as daily log reports, work job orders, machinery reports, condition of, etc., repair, requests, dock yard work, personal reports, fitness and other data. Suggestions and recommendations are also reduced to writing, each one going ultimately to the office files, and the result and credit of such suggestions and worth-while recommendations is given to the right party. This phase of engineering—the clerical phase, it might be termed—causes the men to study conditions more interestedly, and they become more proficient. Writing requires more concentration of thought on the subject at hand, and this produces better results in the end. Ex-Naval Engineer.

Device for Twin Screw Propeller Bearings

The article in the June issue of Marine Engineering, page 344, showing the excessive wear which may result from the friction of sand in the strut bearings of a twin screw propeller, serves to emphasize the fact that few designers are taking any precaution against this common fault of the twin screw installation.

The arrangement which I have used on some twin screw motor installations for fishing vessels is shown in the accompanying sketch. Since I have not been in touch



Section Through Stern Tube

with the owners recently I have not had the opportunity to hear of any trouble experienced. The last installation of this kind, however, which I made on my own auxiliary yawl three years ago has proved entirely satisfactory. When the shafts were removed for inspection last winter I found that not even a drop of water had entered the stern bearings or tubes, much less a particle of grit, although the boat has been operated almost entirely in shallow water.

The sketch submitted shows the details of the installation in my own boat. The two propeller shafts are of steel driven by sprocket chains from one engine placed amidships. Each shaft is provided with one brass sleeve, *A*, in the bearing bushing, *B*, which is made of babbitt. This bushing is slipped into the bronze pipe, *C*, and held in place by a pipe cap, *D*, through the head of which a hole has been bored to clear the brass sleeve on the shaft. By this means the flange of the bushing is securely held in place clamped between the cap and the end of the pipe. The pipe, *C*, is screwed into the bronze casting, *E*, fitted to the side of the boat, and the bearing end of the pipe is clamped by the split hub of the strut, thus making the renewal of the pipe easy in case of injury. Another pipe of the same size is screwed into the inboard end of the casting, *E*, and connected with the stuffing box, *F*. The inboard pipe is tapped for a 3/8-inch pipe or copper tube which connects with a grease cup on the bulkhead placed at the waterline. After the interior of the pipes and fitting has been filled with soft grease and flake graphite the shaft is pushed through. The grease which is forced out of the pipe due to the displacement of the shaft may be caught in a pan and used for future lubrications in the grease cups. The packing in the stuffing boxes prevents the grease from being forced inboard; therefore all the surplus which is forced out into the tubes is gradually squeezed out through the stern bearing, thus preventing anything from entering the latter. Due to the use of this grease packing the stuffing box need not be set up tight, consequently the friction is reduced to a minimum.

The packing which I put in three years ago is still in service. The stuffing boxes have been disturbed only when the shafts were removed for inspection last winter. This inspection revealed that not even the tool marks had worn on the brass sleeves, the use of which was considered necessary to prevent the shaft at the propeller hub from corroding. The extra cost of the installation which I have described over that in common practice is but slight, and it soons pays for itself in repairs, packing and power gained by the elimination of friction.

Jersey City, N. J. H. E. A. Raabe.

Record Ship Completion

The *London Daily News* of June 10, 1918, publishes the following:

A new record in shipbuilding has been created at the yard of Messrs. Workman Clark & Co., Belfast.

A standard ship of over 8,000 tons has been completed in readiness for sea in 15 working days after launching. The previous best time record for a similar vessel was 19 days. Eleven hours after the ship was launched her engines and boilers were shipped and put in position.

London. A. L. Haas.

Who Does the Work?

In the days when the artist had to grind his own paints, a group of people were watching a celebrated artist at work and were exclaiming over the hard work he had done. This was too much for the Irish servant of the artist.

"Him doing hard work? Why every ounce of paint on that there picture I ground with me two hands, and all he had to do was to shove it on the canvas wid a small brush. I did all the work, not he."

This idea seems to be held by a number of workmen to-day. They think because they drive the rivets, punch the plates, or machine the parts that they are the whole push, and the brains of the boss count for nothing.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY H. A. EVERETT

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number if from examination for grade of chief, and by a dagger (†) if from examination for other grades.

Steering Gear Problem

Q. (970).—In a steering head 18½ inches in diameter without any allowance for draw, but with the cross arm 1 inch off center, how should the rudder stock be prepared to receive the head? It appears that the designer might have intended that 2-inch draw could be obtained by shaping the rudder stock so as to put the center of the shaft support (or box) in the true center of the stock. If this is not correct, how could the head be placed on the stock with the necessary draw to hold it securely?

The second point in question is what would happen if 2 inches are removed from one side of casting and the shaft supporting box thrown 1 inch out of center? Should this condition exist in order to make the steering gear work to the best advantage, or should the center of the shaft supporting box be in the exact center of the stock?

For a description of the Robinson steerer see Hyde Windlass Company's catalogue, page 74.

A. (970).—When properly installed, the gear you mention should have the center of the cross arm a short distance off center from the rudder stock. This is to compensate for the unequal lengths of the arms to the screw threads. As the ends on the screw threads move equal

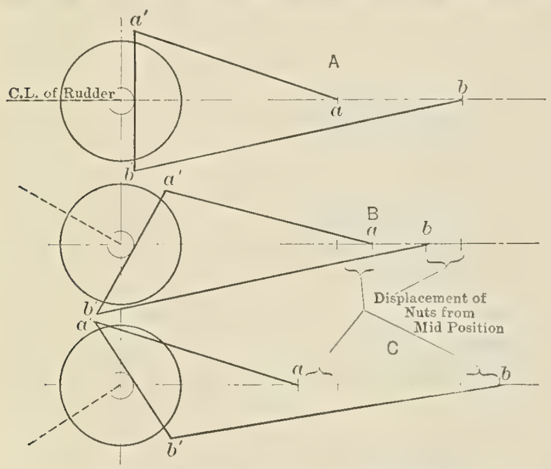


Diagram Showing Action of Steering Gear

distances when the steering wheel is moved, the movement of the ends attached to the cross arm would be unequal, because of the inequality of the arms, unless some compensation were provided. This is done by locating center of the cross arm off center from the rudder stock so that as the rudder is put over the center moves with it sufficiently to equalize the irregularity due to the inequality of the arms.

The figures show this gear diagrammatically; *A* with the rudder amidship; *B* with the rudder about 30 degrees to port, and *C* with the rudder about 30 degrees to starboard. In going from *A* to *B* the nuts on the screw threads (*a*) (*b*) have traveled equal distances, and thus the other ends *a'* and *b'* of the connecting links move unequal distances, and would tend to bend the link *a'*-*b'* unless it were located as shown to compensate this irregularity by its eccentric motion.

Proportions of "Ideal" Cargo Vessel

Q. (972).—In the rebuilding of the American merchant marine is there any tendency in the design of cargo carriers to change radically their dimensions as to length, beam and depth (loaded) from designs of pre-war times, in an endeavor to evolve what may be termed an "ideal" cargo carrier? In other words, is there any tendency to change the proportion of width to length, or depth to width, in the new designs?

(2) Is there a rule or method by which, given the length and beam of a cargo boat, one may roughly approximate its draft, loaded? If so, please explain.

(3) Is there, in your opinion, what may be termed an "ideal" cargo carrier, as to length, beam and depth, representing the maximum on the credit side (earning power) and the minimum on the debit side (construction, operation and maintenance costs)? For example, would a cargo boat the size of the *Leviathan* (formerly the *Vaterland*), every consideration being regarded, be more suitable than a smaller boat, or a number of smaller boats?

A. (972).—(1) There is no radical departure from the proportions existing before the war.

(2) Assuming that you know what the total weight, or displacement, of the ship is to be in the loaded condition you may estimate the draft from the following relationship:

$$\text{Displacement} = \frac{\text{Length} \times \text{beam} \times \text{draft}}{35} \times \text{block coefficient.}$$

Displacement is in tons (2,240 pounds) and the linear dimensions in feet. The block coefficient of modern freighters is from 0.70 to 0.80, and for passenger ships, 0.60 to 0.65.

If the load displacement is not known, it must first be estimated. Pure cargo vessels of low speed usually carry a deadweight (cargo, fuel and stores) approximately twice their weight, which may help you to estimate total displacement, if you know the deadweight carrying capacity. This only holds, however, for the type of boat mentioned.

(3) The dimensions and type of the "ideal ship," as you call it, are purely a function of the character of route and cargo. We are almost always limited to a certain *draft*, governed by the harbors between which the ship plies. With this fixed the *beam* becomes fixed by considerations of stability and this leaves *length* as the only element in which the designer has much latitude. This should be chosen only when the considerations of initial cost (which includes power for the speed desired), character of route and cargo are carefully investigated. Obviously the vessels intended to carry ore or rails need different characteristics from one intended to carry grain or light package freight.

To hit an all round cargo carrier which will be satisfactory for a wide variety of uses the United States Shipping Board are now building two standardized cargo vessels, one to carry 7,300 tons deadweight and the other about 3,000 tons deadweight. The first is 385 feet length by 53 feet beam by 24 feet load draft, speed 11½ knots, and the second of similar proportions but smaller and slower. Great Britain has standardized on three sizes of 3,000, 5,000, and 8,000 tons approximate deadweight carrying capacity. A complete description of the United States

standard 7,300 ton ship appeared in this magazine, August, 1917, and probably this is as near a specific answer as can be given to your inquiry.

NEW BOOKS

Composition of Technical Papers. By Homer Andrew Watt, Assistant Professor of English, New York University. Size, 4⅞ by 7¼ inches. Pages, 431. New York, 1917: McGraw-Hill Book Company. Price, $2.

"An engineer who is inarticulate is quite as useless as one who is professionally incompetent." The very basis of any scientific work necessarily implies ability to give ideas in clear form to those who are responsible for their comprehensive execution, and many successful men realize this limitation long after they have finished the *formal* education which should have provided it. Professor Watt has accordingly prepared a textbook for college use, to supplement the general English course by specific instruction in the composition of technical papers.

A Practical Course in Wooden Boat and Ship Building. By Richard M. Van Gaasbeek, Head of Woodworking Department, School of Science and Technology, Pratt Institute, New York. Size, 4¾ by 7 3/16 inches. Pages, 204. Illustrations, 168. Chicago, 1918: Frederick J. Drake & Company. Price, $1.50, net.

To meet a popular demand for a textbook to assist house carpenters and woodworkers in transferring from their usual occupations to the wooden boat and ship building industries, and especially for those men who wish to qualify for advanced positions and for boat and ship builders who wish to broaden their experience in order that they may prepare for greater responsibilities, this work is offered.

The text is the outgrowth of a pioneer course organized by Pratt Institute early in the war along the lines outlined in another section of this issue of Marine Engineering. The first part of the work is strictly technical in character, giving operations in sequence as they were performed on the job and explaining them in such a way that the average mechanic can understand. In the second part an effort is made to show typical ship construction views, giving the reader an idea of the methods of handling and fastening heavy timbers. Of the 168 pertinent illustrations, 50 are official photographs showing methods of construction and handling the work on wooden ships now being built for the Emergency Fleet Corporation.

The subject is divided under the following heads: The Mold Loft, Stem and Stern Construction, Futtocks and Frames, Outside Planking, Ship Construction, Machines and Labor-Saving Devices, Raising the Frames, Planking and Finishing, Hand Tools Used in Wooden Boat and Ship Building, Shipbuilding Terminology.

The Elements of Navigation. New and Enlarged Edition. By W. J. Henderson, A.M., formerly Lieutenant in the First Battalion Naval Militia, of New York. Size, 4 by 6 inches. Pages, 237. Illustrated. New York, 1917: Harper & Brothers. Price, $1.25, net.

In the new edition, this little volume is brought up to date by including the use of the present nautical almanac and tables recently added to Bowditch's *Practical American Navigator,* the latest navy method of marking compasses and of setting and correcting courses thereby, and methods of computing a constant for meridian sights. The scope of utility for the ϕ' and ϕ'' sight for latitude has been enlarged; new tables to facilitate the use of the moon have been added; the new nautical almanac method of latitude by Polar Star is treated; the important Saint Hilaire method of fixing a position on a Summer line by comparison of a computed and actual altitude is explained; the latest form of navy log is presented, and the book is well-rounded by the addition of a new chapter covering the daily routine of the navigator's work from leaving his port of departure to entering his port of destination.

Ports and Terminal Facilities. By Roy S. MacElwee, Ph.D., Lecturer in Economics and Foreign Trade, Columbia University, Associate Member of the Society of Terminal Engineers and American Association of Port Authorities. Size, 6 by 9 inches. Pages, 315, including over five pages of carefully prepared bibliography. Illustrations, 117. New York, 1918: McGraw-Hill Book Company, Inc. Price, $2.

What *does* make a successful port? Engineers, port officials, business men and other progressive citizens are awakening to the fact that expensive harbor works alone, no matter how well constructed, do not make a port which will succeed in bringing commerce and wealth to a city. There are complex ramifications and subtle interrelations or economic causes which determine the prospects of success of a port. At this time the need for better port and terminal facilities is not only a vital war measure, but of continued and increasing importance in securing to the United States its place as a leading maritime power after the war.

It has been Dr. MacElwee's endeavor to point out in this condensed volume some of the factors which enter into the problem. The material, originally presented in lecture form for the course on "Ports and Terminal Facilities" recently given at Columbia University, has been revised and published with a view to stimulating further investigation, study and analysis of port problems, and to bringing about a better understanding on the part of the general public of the importance of the subject to the nation and the community.

The interest of the writer in ports extends back through nearly a score of years of travel and business abroad, with intensive study of the question during the last six years as head of the Hamburg office of an American firm that built elevators and hoisting machinery. With this background upon which to base intelligent discussion, the chapters on "Piers and Quays," "Wharf Equipment" and "Cargo Tranfer and Handling" contain the maximum of definite information and criticism upon efficient wharfing facilities. The various efficient developments in wharf structure resulting from the conditions existing at the free ports of Hamburg and Bremen are compared with the South Delaware Wharves, Bush Terminal (New York) and the newest methods at the proposed Moyamensing Piers (Philadelphia) under the definite headings *Size of Transit Sheds, Railroad Freight, Car Tracks, Location of Tracks, Teams and Motor Trucks, The Two-Deck Pier,* and *Length of Piers.* In the chapters on "Cargo Transfer and Handling" and "Shed Equipment," the various types of portable conveyors, new cargo masts, heavy-duty cranes and the adaptation of these appliances to varying wharf capacity are illustrated and discussed along the lines already developed by H. McL. Harding and others in recent issues of Marine Engineering.

At this time it behooves America so to develop her potential wharf facilities that they provide for maximum loading and unloading in minimum time. A complete understanding of the principles underlying all well-planned wharves, as Dr. MacElwee has outlined them, and the application of many devices for efficient handling of cargo will go far toward utilizing our possibilities to the fullest extent.

Shipbuilding and General Marine News

**Contracts for New Ships—Shipyard Improvements—
Engineering Projects—Improved Appliances—Personal Items**

SHIPPING BOARD ORDERS MORE WOODEN SHIPS

Contracts Closed With Coast and Lake Shipbuilders for Steamships, Barges and Harbor Tugs

The United States Shipping Board has awarded contracts as follows for 34 wooden cargo vessels, 7 wooden barges and 3 wooden harbor tugs:

Two wooden cargo vessels, 3,500 tonnage, Fulton Shipbuilding Company, Mormon Channel, Wilmington, Cal.

Two wooden cargo vessels, 3,500 tonnage, Seaborn Shipyards Company, Tacoma, Wash.

Two wooden cargo vessels, 3,500 tonnage, St. Helens Shipbuilding Company, St. Helens, Ore.

One wooden cargo vessel, 3,500 tonnage, George F. Rogers & Company, Astoria, Ore.

Two wooden cargo vessels, 3,500 tonnage, Nilson & Kelez Shipbuilding Corporation, Seattle, Wash.

Five wooden barges, 2,500 tonnage, Coastwise Shipbuilding Company, Baltimore, Md.

Six wooden cargo vessels, 3,500 tonnage, Kruz & Banks Shipbuilding Company, North Bend, Ore.

Three wooden tugs (harbor), Leathem & Smith Towing & Wrecking Company, Sturgeon Bay, Wis.

Eighteen wooden cargo vessels, 3,500 tonnage, Universal Shipbuilding Company, Houston Ship Canal, Harris County, Tex.

Two wooden barges, 2,500 tonnage. This contract supersedes and cancels former contracts with Universal Shipbuilding Company.

Additional Contracts

In addition to the above, the Shipping Board has awarded the following contracts for wooden vessels: Midland Bridge Company, Houston, Tex., George E. Cole, general manager, four 5,000-ton steamships, two 3,500-ton steamships and four 2,500-ton steamships; The Wright Shipyard, Tacoma, Wash., two of 3,500 tons; John W. Fahey, Jacksonville, Fla., four of 3,500 tons, and Kiernan & Kern, Portland, Ore., four of 4,500 tons.

Capital Invested in Shipbuilding and Shipping During War Totals $445,154,000

The authorized capital of shipbuilding companies organized in America during the nineteen months ending August 1 amounts to $198,350,000, and the capital of other shipping concerns organized during the same period amounts to $73,103,000. The new capital invested in shipbuilding and shipping enterprises for the entire war period (since August, 1914) amounts to $445,154,000.

Shipbuilding Contracts Awarded by the Shipping Board

Among the contracts recently awarded by the United States Shipping Board are the following:

To Skinner & Eddy Corporation, Seattle, Wash., 35 steel steamships with a deadweight tonnage of 332,800.

The Mobile Shipbuilding Company, Mobile, Ala., D. R. Dunlap, president and general manager, 12 steel steamships with a deadweight tonnage of 60,000.

To K. M. Murdoch, Jacksonville, Fla., six wooden steamships with a deadweight tonnage of 21,000.

To the Missouri Valley Bridge & Iron Company, Quantico, Va., seven wooden steamships with a deadweight tonnage of 24,500.

To the Continental Shipbuilding Corporation, Yonkers, N. Y., one wooden steamship with a deadweight tonnage of 1,500.

The Schaw-Batcher Shipbuilding Company, South San Francisco, Cal., has under construction eighteen 8,800 deadweight ton freight ships for the United States Shipping Board.

It is reported that the Todd Dry Dock & Construction Corporation, Tacoma, Wash., has received contracts to build twelve more 7,500-ton steamships.

The Long Beach Shipbuilding Company, Long Beach, Cal., has a contract to build eight 8,800-ton steel steamships.

The Ames Shipbuilding & Dry Docks Company, Seattle, Wash., has a contract to build fourteen 8,800-ton steel steamships.

The Northwest Engineering Works, Green Bay, Wis., will build six steel, ocean-going tugs.

New Shipbuilding Contracts

The South Bend Shipbuilding Company, South Bend, Ore., has received a contract to build four topsail schooners, each 2,200 deadweight tons.

R. L. Bean, Camden, Me., will build three wooden four-masted schooners, each to be of 1,150 gross tons.

The Gulf Shipbuilding Company, Houston, Tex., G. A. Alonze, president, has received a contract to build several steel oil barges, each with a carrying capacity of 30,000 barrels.

Thomas G. Greenlaw, Harrington, Me., is building three five-masted schooners.

The Portland Ship Ceiling Company, Portland, Me., is building six 3,500-ton wooden ships for the United States Shipping Board.

More Steel for Shipbuilding

At a recent meeting of the War Industries Board, Charles M. Schwab, director general of the Emergency Fleet Corporation, and Edward N. Hurley, chairman of the United States Shipping Board, made a request for an additional allowance of steel plates to carry out the Government's shipbuilding programme.

In addition to an amount of about 50,000 tons of plates per week, regularly furnished for shipbuilding purposes, Mr. Schwab asked for the delivery of an extra 10,000 tons a week during the next three months to serve as a reserve during the winter period.

GOVERNMENT PROPOSES DEVELOPMENT OF INLAND WATERWAYS

Barges and Tugs to Be Built—River and Canal Terminals to Be Provided

New plans of the Government include comprehensive methods for improving inland water traffic. Congress granted authority to the Railroad Administration to use the revolving funds of the rail lines to improve and develop inland water transportation. Acting under that provision of the law the Railroad Administration has already appointed a manager for the New York and other Eastern canals and inland waterways, and a manager for certain Southern waterways around New Orleans.

The Shipping Board has promised to use its facilities for the construction of barges and tugs and similar equipment for these canals and rivers. Government funds and railroad funds will be tied up in these new properties. Furthermore, the new inland water lines will be operated not in competition with the rail lines but as adjuncts to them.

Slow-moving freight, bulk goods and similar traffic can be moved over the water routes, and the rail lines reserved for the package business and the fast-moving freight. It is reported to be the intention of the Railroad Administration to link up all the inland waterways, equip them and operate them in connection with the railroads. When this scheme of inland water traffic is fully developed it will be possible to load a barge at New Orleans, ship it up the Mississippi River to Chicago, and on down East to New York, Philadelphia or any of the Atlantic ports, without once unloading it.

Port Facilities

Another drawback to inland water traffic heretofore has been the lack of terminals. In New York, for instance, it has been very difficult to find terminal space for canal and river lines. With the unified management under the Government it is possible to permit these inland water lines to use the terminals of the railroads. At ocean ports it may be possible to use the docks of the Emergency Fleet Corporation.

This offers a great opportunity to the inland water lines, and one which traffic officials are anxious to take advantage of.

AMERICA LEADS IN SHIPBUILDING

New Yards Rapidly Nearing Completion—Extensive Additions to Old Yards

At the time of our entrance into the war there were 37 steel shipyards in America. To-day there are 72, and the old yards have been enlarged from a capacity of 162 ways to 195, and more are being added. The 24 wooden shipyards of 1916 have been increased to 80 in 1918.

Results, however, are the measure of production, and the launching of 95 steel and wooden hulls July 4 brought home to the nation at large the fact that America has become the greatest shipbuilding country in the world.

Of the 162 shipbuilding plants in the United States, 118 of them are practically complete. And of this number 53 are new yards constructed since our declaration of war. Of the 46 yards still in process of construction, 25 are between 75 percent and 100 percent completed; 3 between 25 percent and 50 percent completed, while only 6 are less than 25 percent completed.

Among the 45 yards under construction are the 4 so-called fabricating yards at Hog Island, Bristol, Wilmington, N. C., and Newark Bay, N. J. Hog Island, the modern epic in shipbuilding, is almost completed, and within a few days its 50 ways will begin to pour an almost daily stream of hulls into the Delaware River. Bristol, with its 12 ways, is virtually a finished yard. The assembling plant of the Carolina Shipbuilding Company was commenced in May and still is in its infancy.

Wherever expansion can be made efficiently, the United States Shipping Board Emergency Fleet Corporation is lending its aid to increase the capacity of American shipyards. The Alameda plant of the Bethlehem Shipbuilding Corporation in California has been authorized to add 10 new ways at an estimated cost of $20,000,000. Their Sparrows Point yard in Maryland is adding 3 additional ways at an estimated cost of $3,000,000. The New York Shipbuilding Corporation, Camden, N. J., is building 5 additional ways at an estimated cost of $7,000,000.

Although these figures show the tremendous work accomplished in building our shipyards, they give but the slightest hint of the stupendous task that has been completed in bringing this end of the nation's shipping programme to its triumphant accomplishment. "It took Germany 40 years to build up her military machine," said Chairman Hurley. "In less than eight months we have built up a shipbuilding machine which, when it gets into full swing, will defeat the military machine of Germany."

French Ships of Large Tonnage Proposed

On August 4, the French Chamber gave approval to a plan which, if carried out, will make France one of the great maritime powers of the world. M. Buisson, Commissioner of Maritime Transports, said he proposed to ask $400,000,000 to develop French shipping on an adequate scale. Great boats of the *Leviathan* type must run between the United States and France.

What France needed, M. Buisson concluded, was a State mercantile fleet. Andre Tardieu, the French High Commissioner to the United States, who also spoke from the floor following M. Buisson, said that France could count upon the whole-hearted support of the United States.

Bethlehem to Build New Shipyard on the Pacific Coast

With the Victory plant at Squantum completed and boats being launched there every few days, the Bethlehem Shipbuilding Corporation has again turned its attention to further expansion, and authorized the construction of a new shipyard located at Alameda, Cal., near the present plant of the Union Iron Works.

A contract for the construction of the plant was awarded to the Aberthaw Construction Company, of Boston, who recently completed the Victory plant in record time, and who has handled practically all the wartime expansion of the Bethlehem Corporation, totaling more than $20,000,000, exclusive of the present work.

The Alameda plant will be the second largest in the United States, exceeded in size only by Hog Island. It will be twice the size of the Victory plant at Squantum and will involve twice the expenditure. The plant, which will be complete for building on ten slips, will cover over a third of a square mile, and from three to four million yards of dredging will be necessary. Large cargo vessels will be constructed, contracts for which have already been awarded to the Bethlehem Shipbuilding Corporation by the United States Shipping Board.

The formal opening of the work occurred on August 13, when the first pile was driven, and there was a big celebration, with addresses by Mayor Green, of Alameda, W. H. Ryerson, of the Aberthaw Construction Company; Mr. Ely, of Monks & Johnson, of Boston, the architects and engineers, and by several representatives of labor, who pledged their hearty support. Five hundred men are already on the grounds, and it is anticipated that the construction work will require the services of approximately 15,000 men within the next few weeks.

More Marine Engineers Needed

The Sea Service Bureau of the United States Shipping Board Recruiting Service reports urgent need of first and second assistant engineers to serve on ships of the merchant marine.

Men holding licenses in these grades have only to address an application to the Sea Service Bureau, United States Shipping Board Recruiting Service, to secure employment at sea. There are no fees for signing on through this bureau.

There was never a time when the rewards for service to a marine engineer were so great as now, both in actual pay and in the chances for rapid advancement.

If some of the new ships are to be moved without serious delay, it is necessary that a considerable number of first and second assistants come forward at once for duty at sea.

NEW SHIPYARDS AND EXTENSIONS OF EXISTING YARDS

Additions, Improvements and Orders for New Equipment

The Great Northern Concrete Shipbuilding Company, Vancouver, Wash., has begun work on its shipyard. This company has received contracts to build five ships for the United States Shipping Board.

The Fabricated Ship Corporation has been organized in Milwaukee, Wis., to build steel steamships. Samuel C. Coddington, of the Lakeside Bridge & Steel Company, North Milwaukee, is treasurer of the new company. George C. Newton is in charge of the chemical plant and equipment of yards and ship construction. Thomas J. Baker is in charge of shipyard construction and outfitting. Alfred L. Newton is chief purchasing officer, and Julius Thielacker is superintendent of steel erection.

The Great Lakes Engineering Works, Detroit, Mich., James S. Keightly, purchasing agent, announces it will more than double its shipbuilding plant at Ashtabula, Ohio.

The Southern California Shipbuilding Corporation, recently organized at Los Angeles, Cal., is planning the construction of a plant at Los Angeles Harbor. Hamilton W. Barnard, A. E. Cromweed, W. M. Carpenter, F. H. Wells and Henry Prince, Los Angeles, and Henry J. Morton, San Francisco, will head the company.

The Terry-Tench Contracting Company, Grand Central Terminal, New York, has organized the Terry Shipbuilding Corporation, and will build a shipyard in Long Island City. It is stated that the company has already received a contract to build twenty barge canal boats.

A corporation has been formed in Quebec, Canada, capitalized at $5,000,000, to take over the Federal Shipbuilding Company, Sarnia, Ont.; the Dominion Shipbuilding Company, Collingwood, Ont.; Dussault & Hutchinson, Levis, Que., and a number of smaller interests. It is stated that the new company will build steel steamships for the French Government.

The Lake & Ocean Shipbuilding Company has been organized at Cleveland, Ohio, to build ocean-going tugs. The company is stated to have already received a contract to build three 150-foot tugs for the United States Shipping Board. James Craig, vice-president and general manager of the National Iron & Wire Company, of Cleveland, is president.

The Greenport Ship Company has been organized in Greenport, N. Y., by W. T. Thompson, G. T. Low and W. A. Sweet, 45 Cedar street, New York.

It is reported that the Federal Shipbuilding Company, Kearney, N. J., will build a dry dock and shipyard to cost more than $8,000,000, on property recently acquired on the Hackensack River.

The Port Arthur Iron Works, Port Arthur, Tex., Francis G. McEwan, manager, will build a plant to repair barges and tugs.

The Adams & Eddington Shipbuilding Corporation has been organized at Port Arthur, Tex., to build concrete ships.

The West Coast Shipbuilding Company, Portland, Ore., H. E. Spear, president, has purchased the yard of the Naull Ship Company at Wilmington, N. C., and will add facilities to construct concrete barges. It is reported that a $1,000,000 order has already been received from the Government to build such barges.

The Union Shipping Company has been organized at Biloxi, Miss., to build wooden steamships. L. T. Hance is manager.

James W. Black and associates, 347 Madison avenue, New York, have organized a company to build concrete barges at Plaquemine, La.

The Ancote Shipbuilding Company has been organized at Tarpon Springs, Fla., and will build a yard for the construction of wooden ships.

The American Lumber Company, Panama City, Fla., has given a contract to the Bates & Rodgers Construction Company, 37 West Van Buren street, Chicago, Ill., to build a shipyard at Millville, Fla. The company has a contract from the United States Shipping Board to build eight 2,500-ton wooden barges. The American Lumber Company was formerly known as the German-American Lumber Company, and is now under Government custody.

The Jahncke Shipbuilding Company, New Orleans, La., E. L. Jahncke, president, will build additional dry docks under a contract from the Emergency Fleet Corporation. The company will also build several 2,800-ton auxiliary schooners.

The Weehawken Dry Dock Company, foot of Baldwin avenue, Weehawken, N. J., is planning to build a shipyard at Peekskill, N. Y.

The Rahberg Dry Dock & Repair Company has been organized by H. W. Ramberg, F. Schmidt and C. Sendixen, 51 Seventy-fifth street, Brooklyn, N. Y.

The Barber Asphalt Paving Company, 233 Broadway, New York, will build a plant at Mauer, near Perth Amboy, N. J., for the manufacture of marine boilers.

The Todd Shipyards Corporation, 15 Whitehall street, New York, according to report, will increase the capacity of all of its shipyards.

The Mid-West Shipbuilding Corporation has been organized at De Pere, Wis. The incorporators include E. G. Mohr, John A. Littell and W. W. Callaher, all of De Pere.

The Slidell Dry Dock & Shipbuilding Corporation, Slidell, La., has acquired property with the intention of constructing a plant to build steel vessels. A. D. Canulette is general manager.

Doullut & Williams Shipbuilding Company, New Orleans, La., will equip a first unit to build steel vessels. The plant will be tripled as quickly as material and machinery can be obtained.

A controlling interest in the Patterson-MacDonald Shipbuilding Company, and an interest in the Seattle North Pacific Shipbuilding Company, Seattle, Wash., has been purchased by James Black, of the Black Masonry & Contracting Company, St. Louis, Mo. The Seattle North Pacific Shipbuilding Company was formerly the Erickson Engineering Company, and is building a large steel shipbuilding plant. The Patterson-MacDonald Shipbuilding Company builds wooden vessels, and is now building ten 4,200-ton ships for the Australian Government.

The Victory Steamship Company has been organized to establish a shipyard and repair works. The incorporators are M. C. Sullivan, 109 West 183d street, New York; B. B. Meade, 1999 Washington avenue, New York, and M. W. Sametz, 672 Park Place, Brooklyn.

The Supple-Ballin Company, Portland, Ore., Joseph Supple, president, will build a large outfitting dock for vessels constructed for the United States Shipping Board. It is stated that it will cost $200,000, and that it will accommodate ten hulls at a time.

The Port Arthur Iron Works, Port Arthur, Tex., is planning the construction of a plant for building and repairing tugs, barges, etc.

The Union Shipbuilding Company, Fairfield, Md., has purchased a 400-foot waterfront and will build an addition to its plant.

The Howard Shipyards & Dock Company, Jeffersonville, Ind., will rebuild its shipyard at Paducah, Ky., which was recently burned.

It is reported that Capt. George J. Pilkington will build a shipyard at Miami, Fla., for the construction of wooden vessels, and that he already has a contract from the United States Shipping Board to build two ships.

The United Shipbuilding Company has been incorporated at Portland, Ore., by J. Cassidy, J. Tierney and J. Devine.

The Pacific Marine Iron Works, Portland, Ore., has received a contract for the Sommarstrom Shipbuilding Company, Columbia City, Ore., to fit out six ships.

The Barling Shipbuilding Company has been incorporated by C. A. Barling, P. Svendsen and E. A. Trik, 205 Seventy-first street, Brooklyn, N. Y.

It is reported that J. J. Schultcher has organized a company at Beaumont, Tex., to build wooden barges.

It is reported that the Gulf States Shipbuilding Company, recently organized, will build a large shipyard at Orange, Tex.

The Russell Shipbuilding Company has been organized at Portland, Me., by F. A. Rumery, R. Payson and M. S. Newcombe.

The Kennebunk Shipbuilding Company has been organized at Kennebunk, Me. William H. Mahoney is president and William H. Culliver is treasurer.

The Queensboro Boat Works, Inc., has been organized by C. Bohn, P. W. Moore and A. S. Honig, Long Island City, N. Y.

Bethlehem Steel Speeds Up Shipyards

At a recent meeting of the stockholders of the Bethlehem Steel Corporation, President Eugene G. Grace mentioned the following facts, which give a very concrete idea of the activity of the corporation in shipbuilding development:

"We have 65,000 employees engaged at the various shipyards, compared with about 40,000 in May. Our new Liberty plant at Alameda, Cal., will come in about the middle of 1919, and this will require 10,000 additional shipworkers.

"The destroyer programme is progressing satisfactorily. On August 6 the Squantum plant launched its second destroyer for the United States Navy. Work on destroyers is being handled at the Union Shipyards in San Francisco and at the Fore River plant. The new Squantum yard at Fore River, which cost about $15,000,000, was built and is being operated for the navy by the company. The work done at this plant is considered the greatest accomplishment in naval construction work in the world. We broke ground on this plant in October, 1917, and by October of this year we expect to have delivered the first destroyer, completely fitted out and ready for operation."

Schwab Sends Labor Day Greeting

Director Schwab's Labor Day greeting to the shipbuilders of America carries his characteristic ring of enthusiasm:

"The winning of the war is just as much dependent upon the industrial workers as it is upon the soldiers; one cannot succeed without the co-operation of the other. I believe our workers realize this more and more every day, as the wonderful record of launching nearly 100 ships on Independence Day shows what can be done when we 'put our shoulder to the wheel' under the spur of enthusiasm and are guided by the highest degree of patriotism.

"The shipbuilders are doing a most essential work, which will have great weight toward making the world safe for those who love freedom and the right of self-government.

"Please convey to the workmen my sincerest thanks and appreciation for what they have done, and my absolute confidence in them for what is to come, as I know they will not fail us at this vital time.

"I am devoting all of my time and energy in an endeavor to flood the seas with ships flying the American flag, and with the help of the workers and my friends hope to put the job 'over the top' in good shape."

School for Arc Welding on Ships

A school for the giving of instruction in arc welding has been opened at the plant of the Lincoln Electric Company, Cleveland, under the direction of the Emergency Fleet Corporation. The course of instruction which will be given under experienced men connected with the Lincoln company will be along practical lines, with a view of training the men taking the course for arc welding in shipyards.

First Concrete Bulk-Oil Carrier Launched

On July 27 the first concrete barge—the *Socony 200*—built by the Fougner Concrete Shipbuilding Company, was launched at the company's yard, Flushing Bay, New York City. The vessel is 98 feet long, 32 feet broad by 9 feet 9 inches deep amidships, and 10 feet 3 inches deep at the ends, drawing 3 feet 10 inches light and 9 feet with a cargo of 370 tons.

American Gear Manufacturers' Association Meeting

The semi-annual meeting of the American Gear Manufacturers' Association will be held at the Onondaga Hotel, Syracuse, N. Y., September 19, 20 and 21. Details of the programme will be announced later.

Fig. 1.—Position of Rudders for Going Ahead

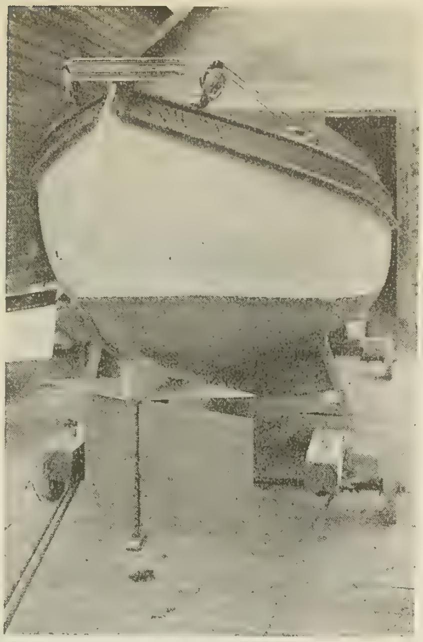


Fig. 2.—Rudders Set for Quick Turning of Boat

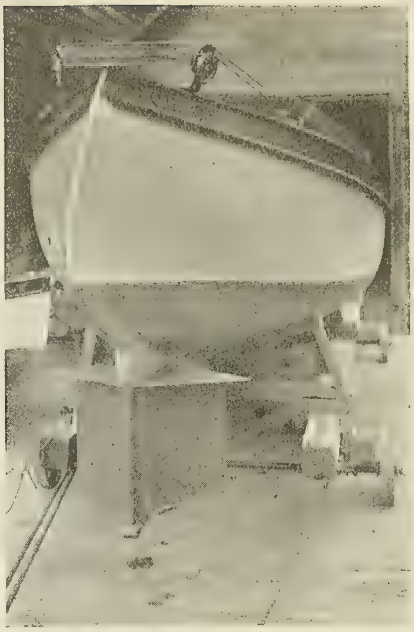


Fig. 3.—In This Position the Rudders Will Quickly Reserve the Motion of the Boat

Reversing and Control Rudder

The General Electric Company has recently equipped a 25-foot motor boat, owned by W. B. Landreth, deputy State engineer of New York, with a reversing and control rudder, with a view to showing the possibility of eliminating reversing turbines from turbine propelled ships.

This boat is capable of backing up with the engine running in a forward direction, and of accomplishing the valuable feat of turning around in its own length. With this rudder the boat can be maneuvered without steerageway—that is, with the rudders placed at right angles to the axis of the keel, and with the engine running at full speed, the boat will stand perfectly still; then, by making a slight adjustment of the rudders, the boat will turn around in its own length and continue to do so until the adjustment is changed. During the process of this circular motion the boat can leave for any point of the compass at full speed. As an illustration of the maneuvering qualities of the rudder this boat was run into a 40-foot slip full speed ahead, turned around and brought out bow first without touching either side of slip.

The rudder on the Landreth boat, the invention of H. O. Westendarp, of Boston, consists of two steel plates 3/16 inch thick, each plate the size of the normal rudder used on this type of boat. The rudder post consists of a steel rod within a steel tube. One plate of the rudder is attached to the tube and the other to the rod. The boat is equipped with two steering wheels, arranged side by side, one wheel to operate the rudder affixed to the tube, the other, the rudder fastened to the rod. The manner in which the rudders are affixed to the stern of the boat is best illustrated in Fig. 1. The two rudders are here shown close together in the position for normal cruising, at which time they are used as an ordinary rudder. The two steering wheels are on the same axis, and when locked together operate as one wheel (Fig. 4) for ordinary cruising. But when the boat is to be turned sharply or reversed, the wheels are instantly released, so that they may be revolved in opposite directions to manipulate the rudder plates.

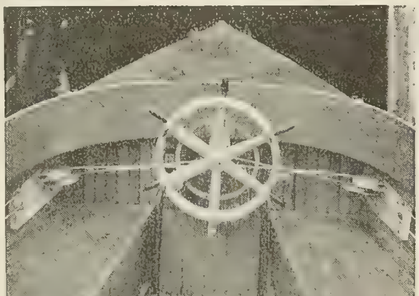


Fig. 4.—Steering Wheels

The ease with which the boat can be made to turn within its own length is remarkable. By placing the rudders in the position indicated in Fig. 2, the boat will turn around in a few seconds and travel back up its own wake. How easily this maneuver is executed is proved by the remarkable photograph reproduced in Fig. 5. This picture of three exposures made on one plate a few seconds apart shows the Landreth motor boat turning in approximately its own length while traveling full speed ahead. The boat made a complete turn in approximately twenty seconds.

With a few turns of the wheels the rudder plates are set in V-shape, as illustrated in Fig. 3. In this position, with

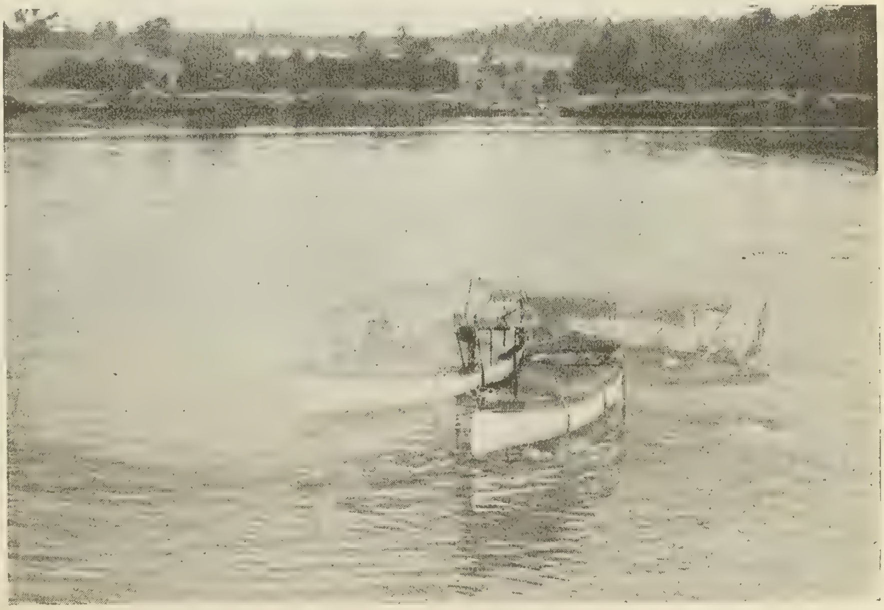


Fig. 5.—Motor Boat Turning in Its Own Length in 20 Seconds

the propeller running full speed ahead, the boat almost instantly stops and starts to run backwards. The boat was brought from full speed forward to backing in nine seconds. With the reversing gear originally installed on this boat it took twenty-six seconds to back. The reversing speed can be controlled to any degree by increasing or decreasing the angular positions of the rudders. The reversing motion is imparted by a stream of water thrown back against the rudder by the propeller and projected thereby forward along the sides of the boat toward the bow. The speed of this water is sufficient to propel the boat backwards at about 30 percent of the full speed ahead. It will be noted that there is a steel plate, or fin, above the rudder which prevents the water thrown back by the propeller from escaping over the top of the rudder. This fin assists in directing the water forward along the sides of the boat. It was discovered by experimentation that the angle of the supporting rod must be 90 degrees or more with the propeller shaft.

Air "Occluders" for Use With Condensers

The successful development of the ejector type of air removal apparatus within the past few years for use in connection with condensing equipment. has been such that it is now recognized by the engineering profession as the best for this purpose. Its light weight, small space occupied and simplicity of operation make it particularly suitable for marine work requiring a high degree of vacuum to be maintained, operating with a minimum amount of steam and freedom from possible breakdowns on account of absence of moving parts.

The aparatus consists of two exhausters arranged in series, with an intercooler of either the surface or yet type placed between them. The first exhauster, known as the primary nozzle, is connected to that part of the equipment from which the air and non-condensible vapors are to be removed, and is so constructed that the impelling steam entrains the air and non-condensible vapors and compresses them to the pressure existing in the intercooler.

The mixture of steam and ejected air and non-condensible vapors are then discharged into the intercooler, which, by condensing the steam and cooling the air and non-condensible vapors, reduces the volume to be handled by the final or secondary exhauster. This in turn reduces the amount of steam required for operating the secondary nozzle, permitting the handling of high ratios of compression, and, as a result, the quantity of steam required by the primary nozzle is relatively small. Without the intercooler the same quantity of air and non-condensible vapors would be handled, but a much larger quantity of steam would be necessary for operating the secondary exhauster.

The quantity of intercooler water required is small, and it can be utilized for boiler feed make up. When used in connection with a surface condenser, provision must be made in the design of the condensate pump to handle the additional amount of cooling water necessary for the operation of a jet intercooler, although this item may be neglected if a surface intercooler is used. The temperature of the intercooler water should be the same as that used for condensing.

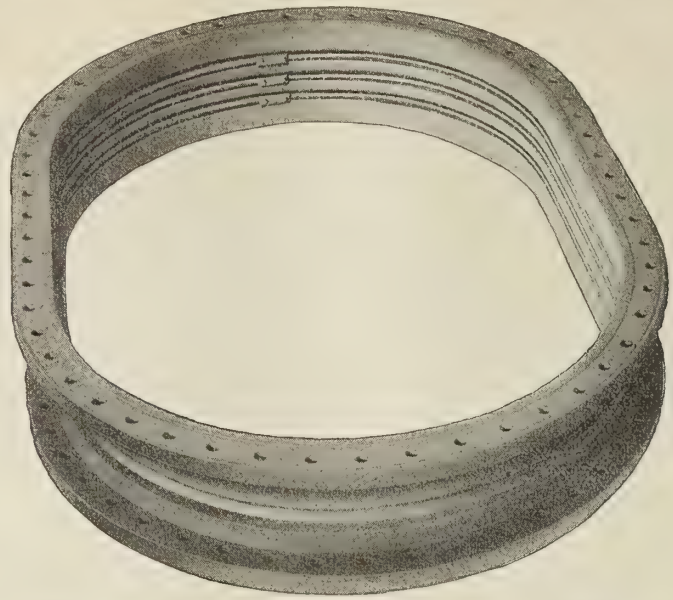
For marine work a surface intercooler is used, as shown on the illustration, permitting the use of sea water in this cooler and avoiding mixing sea water with the steam used by the "occluder."

Each "occluder" is designed to operate under the normal boiler pressures obtaining, but the apparatus is not offered for steam pressures below 140 pounds gage.

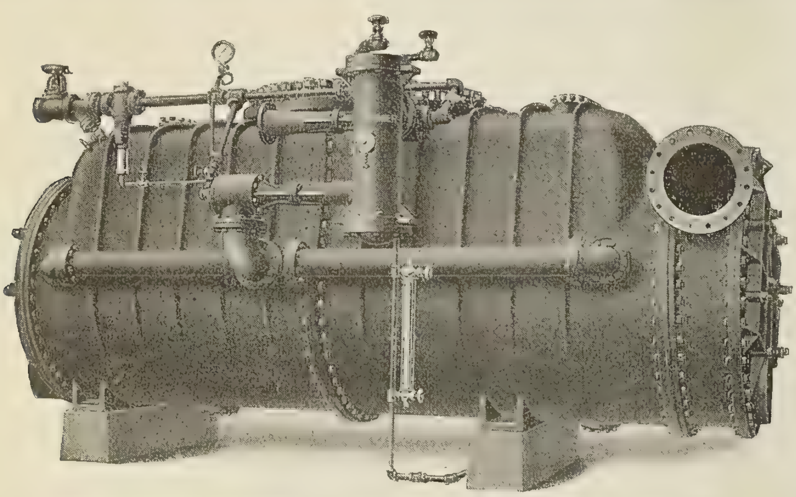
Two or more "occluders" may be attached to a single large condenser. This gives the greatest amount of flexibility in operation. For example, when starting up the main unit two "occluders" can be used, permitting a quick start. After the vacuum has been obtained one "occluder" only need be operated, unless there is an excessive amount of air to be handled.

The general arrangement of the "occluder" is well shown by the illustration of the device as well as the illustration showing the connections between the "occluder" and the surface condenser.

This apparatus is manufactured by the Alberger Pump & Condenser Company, 140 Cedar street, New York City.



Corrugated Copper Expansion Joint for Installation Between Low-Pressure Turbine and Condenser



Marine Installation of Alberger Air "Occluder" With Surface Intercooler

Expansion Joint of Unusual Size

The illustration shows a low-pressure corrugated copper turbine expansion joint manufactured by The Alberger Pump & Condenser Company, New York, measuring inside 7 feet 3 inches by 5 feet, a total pipe area of nearly 31 square feet. This expansion joint, for use between the turbine exhauster flange and the condenser inlet flange, is unusual, both as to the large size and irregular shape.

As will be noted from the illustration, the flanges are very heavy, and reinforcing bars are provided within the corrugations to prevent the joint from collapsing under the influence of vacuum on the inside and air pressure outside of the joint.

The Lone Star Shipbuilding Company, Beaumont, Tex., has received a contract for equipping twenty-two wooden ships, now being built on the Gulf Coast, for the United States Shipping Board.

Westinghouse Brings Out Small Turbo-Generator Unit

To-day it is the duty of everyone to do his utmost in winning the war; and, therefore, no stone should be left unturned in obtaining a greater production with the same number of men, or the same production with fewer men; and no waste in material, time or money should be permitted. To aid in furthering work in many lines the Westinghouse Electric & Manufacturing Company has recently produced a small turbogenerator unit for direct-current service. This unit is designed for 10 kilowatts output, although a temporary load of approximately 12.5 kilowatts may be obtained. A smaller unit of 8.5 kilowatts gives a range of capacity suitable not only for lighting work, but also for the majority of electric magnet work. Its range of capacity, its range of operating conditions and its construction make this an admirable unit for many uses.

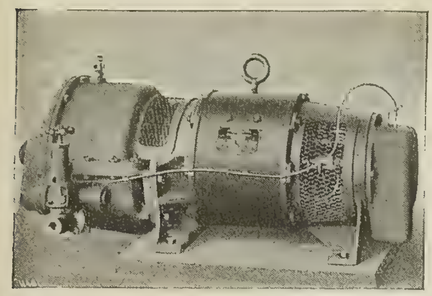


Fig. 1.—Ten-Kilowatt Set Complete

Since the energy developed is direct current, it is finding great favor on steam locomotive cranes, where it is used for lifting magnets. To-day locomotive cranes are in demand as never before; and as many of these cranes are now equipped with electromagnets, this unit enables the purchaser and the user of these locomotive cranes to have all the advantages of the electric locomotive crane in handling scrap and pig iron. It is needless to say that to-day, with the scarcity of labor, any labor-saving device in handling raw material in yards and factories is of high importance in getting out larger production. Its simple, rugged and reliable construction enables it to be used at great distances from machine or repair shops, as there are no reciprocating parts to wear out, and as practically the only attention which it requires is to have its oil well filled occasionally.

In building this 10-kilowatt set the manufacturer has recognized that it must operate under the most trying conditions. For that reason it is as simply constructed as possible, while yet having many of the features found desirable in larger units. Among these is a hand and automatic throttle valve and an emergency over-speed governor. This latter feature is placed on the generator end of the unit and automatically closes the throttle valve of the turbine, if the unit should show a disposition to overspeed. The device consists of a small weight placed in the shaft of the unit, which, at a predetermined speed, engages a trip lever, connected in such a way to the throttle valve that it is automatically closed, thus stopping the unit.

The most important feature of this unit is that it has but one revolving element in which the generator shaft is extended so that it also carries the turbine rotor. This not only makes a very compact machine, but eliminates all coupling and misalinement troubles, and dispenses with turbine bearings and packing.

The turbine rotor is made of a high-grade open-hearth steel forging, accurately finished, in the periphery of which are placed blades of electric furnace steel, which are held in place by pins tightly driven in through blade and rotor. The blades are of the impulse type, and although there is only one row of blades, yet, by means of a reversing chamber, the same steam is passed through the blades a second time, thus allowing complete expansion of the steam.

Since the unit is designed to occupy the least possible space, the manufacturer has equipped the generator with ball bearings (no bearings being required on the turbine) instead of the usual type of surface bearing; thus saving in bearing friction, while consequent decrease in length and weight of the unit is effected. Moreover, these self-alining ball bearings on small units are suited for a variety of services, particularly for marine work, which oftentimes compels the unit to operate at an angle, due to the position of the ship.

As is shown in the illustration, all open places on the unit have been covered with pieces of expanded metal, which protects not only the operation but also the generator parts from incoming foreign matter. Its compactness (the unit is only 3 feet 8½ inches long, 23 inches wide and 18¾ inches high), together with its lightness, enable it to be used where space is valuable or for portable work.

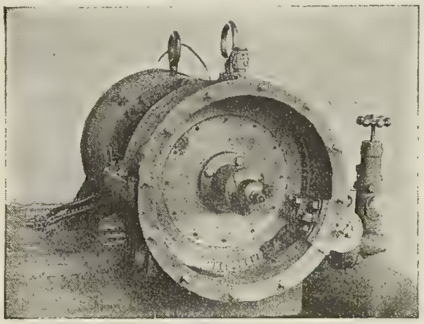
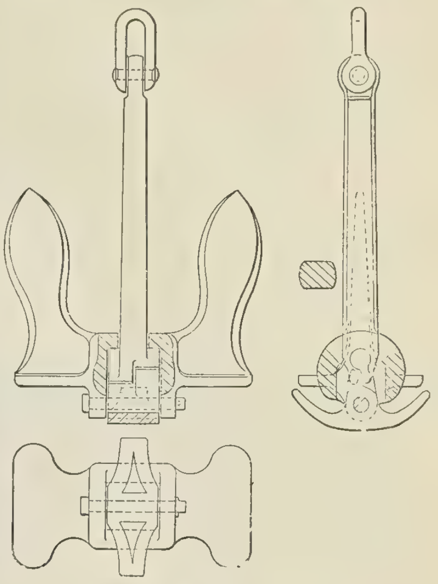


Fig. 2.—Set With Turbine Cover Removed

New Ryan Stockless Anchor

Until the present more or less fault has always been found with the various types of stockless anchors on the market. Naval architects have deplored the fact that anchors would invariably drag for a considerable distance before taking hold, or would foul or roll over on a sandy bottom. To meet this need an improved type of anchor has been devised by Patrick J. Ryan, of 30 Church street, New York City, at the instigation of one of the naval architects connected with a large shipbuilding plant in the South. Well known as a former joint owner of the Baldt Anchor Works in conjunction with the elder Frederick Baldt, of Chester, and intimately in touch with the needs of the service as representative of various steel casting concerns during the last twenty-five years—for the past five years Eastern representative of the Hammond Steel Company and the Detroit Steel Company—Mr. Ryan may be considered an authority on the subject and quite competent to design a model which meets with all the requirements of the United States Navy specifications and the approval of the American Bureau of Shipping.



Ryan Stockless Anchor

Construction of the New Anchor

In working out the problem Mr. Ryan hit upon the idea of utilizing the trip piece on the back of the crown. The accompanying illustration shows the trip piece in position to take hold the moment it is grounded. The shank has staggered teeth, which move in conjunction with the staggered teeth on the trip piece, each operating in an opposite direction. The head is practically closed when in operation, consequently mud or stones cannot accumulate in the mechanism. Most of the other anchors on the market have open heads. In the latter type if a pin or stone should become lodged or jammed under the shank it would prevent the free action of the flukes. Since the pin forms the seat of the shank the flukes would still operate were the trip piece to become broken.

Special Features

Due to the special construction of the anchor it is claimed that it takes hold the moment it is grounded. The side flanges take hold simultaneously with the flukes, and the more pulling strain put upon the shank the deeper the flukes sink into the mud. This result is assured by the downward inclination of the flukes, the exact pitch of which has been carefully calculated from a scientific standpoint. The only way to release this anchor is by heaving to. The anchor can never foul or roll over, it is claimed. A core is provided in the back of the trip which allows the free transmission of water. The strain on the head is equally distributed throughout the entire portion of the crown piece with strengthened fillets, insuring perfect solidity of metal.

Letters patent have already been applied for in all foreign countries as well as in the United States. It is claimed that no machine work is required upon the new Ryan stockless anchor, which reduces production costs to a minimum. Specifications provide for the making of this anchor in all sizes. Since a company is now being formed to manufacture the new Ryan stockless anchors according to the United States Navy specifications, active operations will doubtless be undertaken during the coming month.

Air Planers Save Labor and Speed Up Wooden Ship-building

In a contest conducted last April, at the Foundation Company's shipyard at Portland, Ore., the workman shown in the photograph reproduced on this page planed 385 square feet of a wooden vessel's side in five hours, while eight men, with hand tools, finished only 275 square feet of surface in seven hours. The pneumatic tool used in this contest was an air planer, Model C, manufactured by the Shipbuilders Pneumatic Tool Company, Portland, Ore. It is operated by compressed air turbines attached at each end of the planer head and mounted on ball bearings in a frame. The planer head is made of phosphor bronze and has two knives.

The planer operates at a speed of eight thousand revolutions per minute and, it is claimed, gives a perfect surface over treenails, knots, calking, marine glue and pitch pockets. It weighs only ten pounds and has practically no limitations in edging, planing, adzing and surfacing of wood. Being a portable tool, it saves carrying heavy timbers to a stationary machine for dressing and it can be taken to the work on the vessel without any delays in lining up the work. Therefore its use results in saving both time and labor and speeding up production in the shipyard.

Surfacing a Ship's Side With Compressed Air Planer

PERSONAL

W. T. Smith has been elected president of the Chester Shipbuilding Company, Chester, Pa.

L. T. Kniskern, superintendent of construction of the Chester Shipbuilding Company, Chester, Pa., has been appointed general manager of the company.

Dr. C. W. Doten has been appointed executive head of the industrial service section of the industrial relations group of the Emergency Fleet Corporation, vice Meyer Bloomfield, who has been named advisory counselor of industrial service and employment.

G. A. Tomlinson, general manager of the New York Canal section of the United States Railroad Administration, has been appointed Federal manager of New York and New Jersey canals.

John G. Pew, formerly president of the Peoples Natural Gas Company, and the Home Natural Gas Company, Pittsburgh, Pa., has been elected vice-president and general manager of the Sun Shipbuilding Company, Chester, Pa.

Benjamin P. Young, formerly of Young, Rakestraw & Ferguson, naval architects, Philadelphia, has opened an office as naval architect and ship and engine surveyor, at 1711 Diamond street, Philadelphia. Mr. Young has severed his connection with Cox & Stevens, naval architects, New York.

F. W. Ballard has been appointed power specialist, attached to the office of the vice-president in charge of construction of the Emergency Fleet Corporation.

Alex. Maitland has been appointed district supervisor in the Division of Wood Ship Construction of the Emergency Fleet Corporation, Sixth District, with headquarters in the Carter Building, Houston, Tex., succeeding Charles N. Crowell, assigned to other duties.

Fred A. Ballin, formerly secretary and treasurer of the Supple-Ballin Shipbuilding Corporation, Portland, Ore., has been elected president of the corporation, succeeding Joseph Supple, retired.

E. C. Kerrigan was appointed general purchasing agent of the Great Lakes Engineering Works, Detroit, Mich., on August 5, succeeding James S. Keightly, resigned.

E. P. Dillon, manager of power division, New York office, Westinghouse Electric & Manufacturing Company, has resigned to become general manager of the Research Corporation of New York.

David Hollywood, formerly general manager of the Ames Shipbuilding Company, Seattle, Wash., has been appointed works manager of the South Western Shipbuilding Company, San Pedro, Cal.

F. H. Charbono, for many years representing the Independent Pneumatic Tool Company in the East, has been appointed manager of the Southern district of the company, with headquarters at 1721 Jefferson Company Bank Building, Birmingham, Ala., succeeding George C. Wilson, resigned.

E. W. Swartwout has been appointed manager of the Philadelphia office of the Nordberg Manufacturing Company, Milwaukee, Wis., with the special duties of serving the company's interests with the various departments of the Emergency Fleet Corporation in Philadelphia and the various technical departments of the government in Washington.

Henry Lysholm, general manager of the New Jersey and Pennsylvania Shipbuilding Companies, Gloucester, N. J., has been elected vice-president of the Pusey & Jones Company, Wilmington, Del.

M. E. Davis, superintendent of the New Jersey Shipbuilding Company, has been elected general manager of the combined plants of the New Jersey and Pennsylvania Shipbuilding Companies, Gloucester, N. J. It is understood that Hugh V. Ramsey, superintendent of the Pennsylvania yard, will be made general superintendent, of the two plants.

Albert W. Murray, assistant superintendent, Morse Dry Dock & Repair Company, Brooklyn, N. Y., has been promoted to the position of superintendent of the company, vice E. P. Morse, Jr., resigned.

OBITUARY

George W. Dickie, one of the leading naval architects in the United States and a vice-president of the Society of Naval Architects and Marine Engineers, died August 16, aged 74.

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Removal Notice

BEGINNING with the first of October, the Government will occupy the entire space of the Printing Crafts Building. This has compelled a change in home for MARINE ENGINEERING. We have moved—moved to larger quarters—and happily announce our new address as 6 East 39th Street, New York, where we shall be pleased to receive our contributors and subscribers and advertisers at any time.

The Fourth Liberty Loan

THE Government has opened its Fourth Liberty Loan campaign. The money is needed to carry forward the work of the war. It is of vital interest to every man, woman and child that this issue be taken up with a readiness of response that will of itself be our answer to the enemy peace moves recently launched. No patriot living wants a peace at this time with the enemy country still uninvaded and the might of the enemy will still practically unbroken. Kaiserism must be made a limp and lifeless thing, stripped of all power for harm for all future time, before peace can decently be considered by the allied nations. Every man among us well realizes this. We are in the war to win, and to win through sheer power of arms. The way to bring this about, for many of us, is to give freely of our own resources in time and money to make this loan a whirlwind success. The Government will do the rest. Your bit and my bit and the other fellow's bit all added to the sum total will bring victory in the field. Let us snap up this loan as no other loan ever was snapped up.

Hot Bulb Engines

THE speed at which the majority of hot bulb engines operate is a good deal too high for the most efficient speed of the propeller, but usually the other advantages of the oil engine are sufficient to permit this loss of efficiency to be neglected. For instance, with fairly large hot bulb engines, say from 100 to 500 horsepower, fitted to such craft as tugs, barges and large auxiliary trading vessels, the speed is generally between 220 revolutions per minute for the larger engines and 350 revolutions per minute for the smaller sets. A much more satisfactory speed, especially for tugs and for large auxiliaries, would be in the neighborhood of 100 revolutions per minute, and it is therefore of interest to note that in America considerable progress is being made in the employment of reduction gears in connection with hot bulb engines. With some of the craft now under construction, carrying up to 3,000 tons of cargo, reduction gears in connection with 320 horsepower hot bulb engines are being fitted, reducing the speed from about 250 to under 80 to 90 revolutions per minute. A tug was recently designed 66 feet in length, with a beam of 17 feet 8 inches, fitted with a 100 brake horse-power hot bulb engine, running at 340 revolutions per minute, but driving the propeller at 93 revolutions per minute through a turbo reduction gear. By this means a propeller 4 feet 6 inches in diameter could be fitted, and it is stated that the loss in the gear is not more than 2 percent.

Liberty Loan Clubs

IN connection with the Fourth Liberty Loan, the Government, in order to build up united action in the campaign, has proposed a scheme for the consideration of industrial owners and managers. It is suggested that in every plant there be organized a Liberty Loan Club, each having its leader and corps of speakers, with meetings held daily during the progress of the campaign—all for the purpose of engendering interest and activity in the loan.

The bonds must be sold. With certain picked employees circulating through the noon gatherings selling bonds, and with a few well-chosen speakers on the platform pointing out the great and urgent need of success, with an interpreter or two for the benefit of workmen who require interpreters, such a method for aiding the Government in placing this issue of bonds ought to be eminently fruitful. At any rate, it should be seriously considered by manufacturers and owners everywhere as a plan well worth trying.

But BUY BONDS!

Americans as Shipbuilders

RECENTLY a delegation from England representing the press visited our shores and shipyards. One of their ports of call was the Hog Island yard. A guide escorted the gentlemen proudly through. He said:

"From a swamp, in September, 1917, visited only by stray cows, Hog Island to-day, in a period of less than a year, has more ways for big ships than all America possessed before the war. By December, 1918, it is hoped, the fifty ships which you see will have been completed, launched, loaded and dispatched with full cargoes to Europe. Fifty others will then be on the stocks."

The delegation stood frankly amazed. Nothing in all the stupendous war activities of the United States had been more impressive. A correspondent representing the *Manchester Guardian* spoke later in the columns of his paper, to wit, as follows:

"Hog Island is a modern miracle. The first sight of it to a British sailor makes him doubt the evidence of his

eyes. Others with me had that same feeling. We knew the Clyde, the Tyne, Belfast and the Mersey, and had been proud of their individual and collective achievements.

"But Hog Island was something outside our experience, beyond our imagination. We gazed with wondering eyes at its mighty framework of girders, its grand array of cradles and slips. We counted the ships being built in a row side by side, and found that they numbered fifty. That was what we could scarcely credit. 'Small ships!' one man, selfishly patriotic, suggested. 'Each of 7,500 to 8,000 tons,' replied our guide. Multitudes of men were busy on these ships working at record-breaking speed. We were told that an 'honor system' had been inaugurated. Gold and silver medals were awarded for meritorious services, and encouragement was given to the men to develop ideas that would increase tonnage and would inspire their fellow workers to greater efforts."

We shall make no comment. The thing tells its own story. We—— Wait! Just one word. America must strive to hold this supremacy, so frankly acknowledged us by our cousins across the water, for all time to come.

It can be done.

Advancing Foreign Trade

THE position which this country is destined to occupy in the markets of the world has been anticipated by a small body of men who have grouped themselves together into an organization known as the Allied Industries Corporation. The general plans laid down have been formulated to co-operate very closely with the various domestic and foreign trade bureaus of our government in order to work in harmony with the various international foreign trade bureaus of the allied and neutral governments. The corporation plans to conduct the broadest campaigns of education possible and to promote and embody in this campaign principles of good will and international understanding. Thus it hopes to generate an influence that will be made to radiate as widely as possible through a comprehensive system of public education having as its object the fostering of reciprocal international trade relation, establishment of international customs tariffs, standardization of merchandise, the promotion of international legislation affecting trade relations and all international good will and co-operation. Besides investigating international market requirements and international natural resources, it will tabulate international exporters and importers for the service of buyers and consumers and disseminate information on these subjects. Also, international trade markets and patents will be listed and international financial investigations made and kept on file. In other words, the Allied Industrial Corporation aims to become a communicating link for and between the organized trade association of the entire world.

The Allied Club, which will be operated in connection with the association, will afford all the usual and some very unusual club privileges to its members, who will consist of foreign and domestic importers and exporters, brokers, bankers, lawyers, shipping men and commercial agents—a membership that will include all of the proposed branches at London, Paris, Milan, Brussels, Lisbon, Shanghai and Tokio. The home will be located in the Grand Central Palace, New York. Since New York is very definitely the gateway through which American goods must go out to the markets of Europe and South America, just as it is the gateway through which the products of these countries must largely enter the United States, it is proposed to centralize in New York as far as possible the entire flow of foreign trade. Yet it is not the purpose of the organization to narrow the gateway, but to broaden it, very definitely locating a place where buyers from all the world may come together under one roof to facilitate the exchange of commodities and the interchange of ideas.

We feel that this indicates a very important step in the advancement of the foreign trade of the United States. Manufacturers of boilers and boiler accessories should take advantage of this opportunity to build up an international market for their products. Trade extension is always of vital importance, and what with the promised reconstruction period of France alone after the war the Allied Industry Corporation holds out special encouragement and ready inducements for all manufacturers to show a little life.

The American Merchant Fleet

RECENTLY the United States Shipping Board issued a statement to the effect that "within the jurisdiction of the United States Shipping Board at the present time (September 1, 1918) there are 2,185 seagoing vessels, totaling 9,511,915 deadweight tons. Of these, 1,294, totaling 6,596,105 deadweight tons, fly the American flag. Under charter to the Shipping Board and to American citizens there are 891 foreign vessels, totaling 2,915,510 deadweight tons.

"At the time the United States entered the war," the statement continues, "the American merchant marine included approximately only 2,750,000 deadweight tons of seagoing vessels of over 1,500 deadweight tons. This expansion of the fleet within the jurisdiction of the Shipping Board has come about for the most part during the last year."

The fleet lists were as follows on September 1, 1918:

	Number	Deadweight Tons
Requisitioned American ships	449	2,900,525
Ex-German and ex-Austrian ships taken over	100	644,713
New ships owned by Shipping Board	256	1,465,963
Old lake steamers transferred	31	117,800
American merchant ships not yet requisitioned (of over 1,500 deadweight tons)	377	980,459
Dutch steamers requisitioned	81	486,945
Foreign ships chartered to Shipping Board	291	1,208,411
Foreign ships chartered to American citizens	600	1,707,099
Total	2,185	9,511,915

In this swift expansion of our shipping facilities the American people have much of which to be proud. And the end is not yet. It should be a matter of but a very few months now when our total losses due to submarines will be completely overcome.

The Old Sailing Navy

The old sailing navy provided the finest possible mental and physical training, Admiral Lord Charles Beresford is quoted as saying. It taught initiative, presence of mind, accurate observation, habitual defiance of danger, ready resource, and an extraordinary hardihood.

At sea, a man holds his life on the condition that he possesses these qualities. Frequent emergencies are part of the ordinary routine, and the penalty of failing to meet them is inevitable. There is no arguing with a gale of wind.

Owing to unprecedented transportation facilities, your copy of MARINE ENGINEERING may reach you late. If you do not get your copy in time please do not be impatient, as it will eventually reach you.

What Ships Mean to Us

President Wilson says:

"We must supply ships by the hundreds out of our shipyards to carry to the other side of the sea—submarines or no submarines—what will every day be needed there; and abundant materials out of our fields and our mines and our factories with which not only to clothe and equip our own forces on land and sea but also to clothe and support our people for whom the gallant fellows under arms can no longer work; to help clothe and equip the armies with which we are co-operating in Europe, and to keep the looms and manufactories there in raw material; coal to keep the fires going in ships at sea and in the furnaces of hundreds of factories across the sea; steel out of which to make arms and ammunition both here and there; rails for worn-out railways back of the fighting fronts; locomotives and rolling stock to take the place of those every day going to pieces; mules, horses, cattle for labor and for military service; everything with which the people of England and France and Italy and Russia have usually supplied themselves, but cannot now afford the men, the materials, or the machinery to make."—*Extract from an address delivered by the President, April* 16, 1917.

What Do Ships Mean to You?

Importance of Large Shipping Fleet is Generally Recognized—Replies to a Question That was Recently Asked—Exporter and Importer Equally Concerned

UPON ocean tonnage the outcome of the war depends. Leaders of the Allied armies and all students of the stupendous conflict in which the greater part of the world is engaged are agreed that the winning of the war depends upon our ability to build ships in required numbers and with sufficient speed to move our armies to the battle lines, maintain them with supplies and the Allies with food.

Upon the United States Shipping Board Emergency Fleet Corporation has devolved the task of supplying this vital need. That our Government officials are keenly alive to this need of ships is shown in the accompanying replies to a question which Chairman E. N. Hurley, of the Shipping Board, has addressed to heads of important departments. The essence of that question was: "WHAT DO SHIPS MEAN TO YOU?"

The replies are wonderfully informative, disclosing, as they do, that there is not an angle of our national life that is not in some way interlocked with shipping. Ships are equally essential to the exporter and to the importer. They are the reliance of the merchant, and farmers are now beginning to realize that without ships to move his grain and produce, these will congest in storehouses and in wharves. They are essential for the food and fuel supply of ourselves and our allies. In the following replies to the query, "What do ships mean to you?" our numerous other needs for ocean tonnage are described.

THE GREAT MERCHANT FLEET WHICH THE SHIPPING BOARD IS CONSTRUCTING MEANS MORE SOLDIERS ON THE FIGHTING FRONT

NEWTON D. BAKER, SECRETARY OF WAR

Each new ship added to our transport service means more American soldiers on the fighting front, more American soldiers in training behind the firing line, more supply workers to make secure the men in camp or trench, more doctors and nurses to care for the wounded, more food and clothing and comforts for our forces abroad, and more vital assistance to our associates there in the war.

Ships, then, are indispensable. Greatly as our people have responded in all phases of war activity, the registration of their power is still determined by ships. We have to bridge 3,000 miles of dangerous water to strike the blows which are required to end the menace of ruthless militarism. Not a bullet can be fired nor a mouth fed by Americans over there unless a rivet has first been driven home here.

They have, indeed, done well. This nation, and all that is free and hopeful in mankind, owes to them a great debt for the earnest manner in which they have rallied to their task. But they will do better, for their souls are in their work, and the human soul, when inspired with visions of noble service, is ever capable of tapping new reserves.

I bid them speed! The army will be ready when the ships are ready.

SHIPS WILL MAKE FOR CONSERVATION

HERBERT HOOVER, FOOD ADMINISTRATOR

No phase of our war programme can be wholly divorced from the shipping situation. This is clearly shown in the case of foodstuffs. It is the shortage of ships which has placed upon us the responsibility of supplying the major share of all foodstuffs needed to maintain the millions of soldiers and civilians who are bearing the brunt of Germany's assaults upon the Western front.

While it entails sacrifices on the part of each of us, our service to those across the sea cannot be regarded as a burden. This is our war just as much as it is theirs. It is not, as in Germany, the war of a few people who control the multitudes. It touches each one of us, and if we are to be victorious each one of us must respond willingly and gladly to every appeal.

Until we are building ships fast enough to supply all war demands, we cannot hope to be relieved of the responsibility for utmost conservation. In this year's crops we very probably see the height of our war-time food production. As we are drawn deeper into the war the situation must become more serious; we must look for a steady degeneration of labor and for reduced production. More and more men will be drawn from accustomed pursuits and enter into direct war activities, as fighters or industrial workers who are supplying the actual sinews of war.

It will become increasingly difficult for us to provide for both the people in Europe and those in America unless by production of ships we can partially open up other sources of supply. So great is the present stringency, these other ports must be eliminated, so far as possible, in order that our few ships may ply at capacity. The effectiveness of each ship taken from the Australian trade, for instance, is trebled, as it could make three round trips from Europe to America while making one from Liverpool to Sidney. Each one diverted from the Argentine doubles in efficiency.

Only if we have more ships can we expect any degree of freedom in manipulating the food supplies of the world so that Europe may be fed without a serious drain upon other countries. We are faced with this tonnage prob-

lem in meeting our present sugar shortage, which is almost wholly due to difficulty of transport and consequent inability to tap stocks in distant sources of supply.

Until the world's tonnage is sufficient to allow freer use of vessels, European supplies must be maintained largely from what can be spared in the United States. The measure of our service may be lightened only in direct ratio to the increase in marine shipping facilities.

SHIPS ARE A VITAL FACTOR IN THE PROBLEM OF MAINTAINING THE NATION'S FUEL SUPPLY

HARRY A. GARFIELD, FUEL ADMINISTRATOR

The Fuel Administration must depend upon ships to supply two great and important sections of our country with coal to keep the people warm and to maintain the constantly increasing industrial activities necessary to the proper prosecution of the war. New England, crowded with great war plants which are turning out a multiplicity of material for our army and navy, must be supplied, to a large extent, by ocean shipments from Southern tidewater ports. The overburdened railways cannot carry more than approximately one-third of New England's coal supply for the year. The remainder demands ships. Without them the wheels of New England's war industries must stop, and New England's people must suffer.

The great section of our country at the northern end of the Great Lakes must likewise depend upon shipping for its coal supply. A great fleet of coal carrying vessels must be in constant service from the lower lake ports to the great coal docks of Lake Superior and Lake Michigan, throughout the open season, if the great Northwest is to secure its winter coal supply. The enormous tonnage of coal demanded by this section cannot be imposed upon the already overburdened railroads. It must move by water, and it must move while the Great Lakes are open for navigation.

All of this means ships, and, as the programme of the Shipping Board continues to be worked out, ships sufficient to carry the coal supply become available. To-day, ships are available to move the constantly increasing coal production. But railroads, ships and coal must grow together, in order that a co-ordinate machinery may be always at hand to keep the nation supplied with fuel.

Fuel is a vital factor in maintaining the nation's shipbuilding and in moving the nation's ships after they are built.

As the armies of the United States in France are enlarged, which enlargement is steadily going on, the materials to support them will have to be increased correspondingly. This means more ships to move the commodities of warfare; it means more materials which have to be manufactured; in means increased railroad capacity to forward raw materials and finished products; it means more factories to produce more materials.

All of which, depending on ships for the final transportation over three thousand miles of ocean, likewise means more coal.

With every additional ship that puts to sea the fuel requirements of the Government are enlarged. Each must be supplied with fuel, either coal or oil. The annual coal requirements budget of the Fuel Administration prepared early in the year included ten million tons of bituminous coal for bunkering of ships.

Later estimates of coal required for bunker purposes for 1918 for steam coal-burning vessels of 500 gross tons and over in ocean service, including American and foreign vessels bunkering in United States ports and excluding warships operated by the navy, bring the total requirements up to 11,790,000 tons. With tonnage for United States naval ships, amounting to 4,269,000 tons, added, the total requirements for this particular class of coal have grown to sixteen million tons. This is the July, 1918, status. The increased requirement is already 100 percent beyond that of last year. As the programme of the Shipping Board gains impetus the responsibilities of the United States Fuel Administration correspondingly enlarge.

SHIPS ARE REGARDED AS VITALLY ESSENTIAL FOR THE GREAT PART WE ARE DESTINED TO PLAY WHEN THE WAR IS WON AND OVER

BERNARD M. BARUCH, CHAIRMAN OF THE WAR INDUSTRIES BOARD

When primitive man's needs became larger than his immediate environment could satisfy, he traveled by land to wider sources of supply. Then he learned to reach new fields by water. Since then he has discovered the means of using a third element—air; but that, as yet, is not usable industrially. The fullness of his life depends upon man's ability to use land and water transportation. His needs in peace were great. In time of war they were multiplied. It is not too much to say that the very life of the nation depends upon her unrestricted access to remote points; it might be even better to say that the very life of the world depends upon it, since the fate of the world is so indissolubly bound up with that of America and her associates.

All of this is expressed in forms of ships. Others will write of what ships mean in relation to men, to material, to food, to fuel, and to trade. I can make plain how much they mean to the governmental agency with which I am connected and which stands as a point of supply for our three great war factors—the War Department, the Navy Department and the Shipping Board. Of equal importance, it is charged with the duty of answering the needs of the civilian population.

In each of these enterprises ships are vital essentials. Over the water routes come to us the nitrates for explosives; manganese for steel; wool for clothing; hides for leather; oil for fuel; rubber for many industrial and medical purposes; cotton, hemp, sisal lumber, minerals of various sorts, and hundreds of other items necessary to prompt and effective conduct of the war.

Ships have helped to lay the foundation of our increasingly great part in the war; ships will help to make certain the great part we are to play in the days to come, for America has emerged from her isolation and her ships will project her friendship and commerce over all the world's waters.

DEVELOPMENT OF TRADE IS DEPENDENT UPON ADEQUATE SUPPLY OF OCEAN TONNAGE

VANCE MC CORMICK, CHAIRMAN OF THE WAR BOARD

The increase in our shipping facilities through construction of a large number of American vessels means for the War Trade Board an opportunity to realize its programme and policies along broader and more positive lines than has heretofore been possible. The functions with which this Board has been entrusted by the President comprise, generally speaking, the war-time regulation of our foreign trade, and the dependence of trade upon shipping is a truism almost too obvious for statement here.

Regulation of our foreign trade, be it noted, and not restriction, is the essential mission of the Board. Unfortunately, however, the world shortage of tonnage and the demand for ships, ships and more ships to transport and maintain our rapidly growing armies in Europe and to supply our co-belligerents have forced the Board to work to a considerable extent along lines of restriction, particularly of imports, deferring the almost equally important function of encouraging and developing our foreign trade under war conditions.

Construction of American ships in large quantities means to us the opportunity to license freely the importation of all required raw materials of foreign origin, where we are now compelled to pick and choose among most, more and less essential supplies and to adjust by painful study and calculation the relative amounts of indispensables which we can and must import.

It means the possibility of free export of American commodities which can be spared under our war programme to overseas destinations to help pay for our great war imports or raw materials and to redress the adverse balance of trade running so strongly against us in many foreign countries. Payment for war imports by commodity exports rather than by our precious and limited stocks of gold is a war measure of prime importance, and it should not be forgotten that exports even of articles to us of non-essential or luxury character which help us to pay for essential imports may, from a war standpoint, be regarded as essential. Adverse balances of trade mean the payment of higher prices for foreign purchases, each penny taken from the exchange value of our dollar in the marts of a foreign land meaning an extra cent added to the price charged us, and adverse balances may in this war be redressed only by shipment of wares. Our enterprising merchants and manufacturers, too, laboring under so many war burdens, are entitled to the openings for export which more ships will give them.

Shipbuilding means to us, *inter alia*, an easier and more grateful task in our negotiations with the neutrals. Not only will our exchange problems, noted above, be lightened when we are no longer compelled to pay such exorbitant prices for the carriage of freights in neutral steamers but can transport them more and more in our own vessels, but our offers of supplies to the neutrals can be more liberal, our calls upon their tonnage less pressing and our relations with them more facile when our great shipbuilding programme comes into full fruition.

So, too, we shall be able to fulfill in far more liberal measure our obligations toward our allies and friendly neighbors in Latin-America, who are dependent on the United States for so many of the commodities required for their well-being or comfort and for whose products the natural market is in such large measure offered by this country. Lack of ships has, during the war, hampered our trade relations with these neighbor nations of the American continent more than we like to contemplate; adequate American tonnage means an opportunity for full development of the great trade possibilities between the peoples of this hemisphere opened up in consequence of the war and of that friendship and understanding which commercial intercourse does so much to promote.

SHIPS WILL HELP TO DESTROY THE MILITARY DESPOTISM OF THE GERMAN KAISER

WM. G. MC ADOO, SECRETARY OF THE TREASURY

We are in the midst of a great war—a war involving the very life and security of America.

Our job is to destroy the military despotism of the German Kaiser and to make the Stars and Stripes wave triumphant over the battlefields in France and thereby re-establish liberty and make safe for the future all the free and independent peoples of the earth. That is our job, and it is the job which America's brave soldiers and sailors cannot do by themselves. They can do it only if the laboring men do their full share, and their full share is to work with all their might and main to turn out quickly the ships which are imperatively needed to carry our gallant soldiers to France and to keep them supplied with food and clothing and arms and ammunition and great guns, so that they may smash the Kaiser quickly and restore peace to a stricken world. Wouldn't it be a crime if we who stay at home should send 1,800,000 of our brave sons to France and then fail to supply the ships and all the munitions of war to enable them not only to save our liberties, our lives and our property, but at the same time to fight successfully the German armies against whom we have sent them! Think of the bloody task we have given our soldiers and sailors and how much better off we are who stay at home, with our lives protected, plenty of work to do, and high wages and nothing to endanger our future unless we fail to back our boys in the armies in France so that they can win the great victory for us.

The one thing most needed now by America's soldiers and sailors is ships, ships, ships. We need ships to carry our gallant boys across the stormy waters of the Atlantic through the hazardous submarine zone; ships to send them guns and bullets and powder and food and clothing, without which they cannot fight. It is the men working in the shipyards upon whom the nation must rely to build these ships in time. What a splendid privilege and opportunity these men have to save democracy! What a fearful calamity to the world it would be if these same men should fail to turn these ships out in time!

AMERICA'S FREEDOM OF THE SEAS DEPENDS UPON HER SHIPPING

WILLIAM C. REDFIELD, SECRETARY OF COMMERCE

I will tell in a few words what shipbuilding work means to the Department of Commerce.

The commerce of the United States is like a man in a strait-jacket. There are certain things he may do; many more he may not do. Freedom, flexibility—these are gone. Commerce has become a weapon of war and is as truly directed to military uses as are armies or artillery. Current commercial thought is of War Trade or War Industries, and the necessities involved in these phrases are like bands about the expansive force of our Commerce holding it tight.

But Commerce is an expansive force, and it cannot be wholly thus restrained. Certain needs of our hundred million people must be supplied, and when reduced to their lowest, still demand a large share of industry to assure that the processes of living shall continue.

Great opportunities lie open to us. In South America and elsewhere men seek the credit and the enterprise of which we are now the greatest reservoir. The Future of America calls to the Present not to neglect it, and Opportunity beckons from many a land with insistent finger. Much that we need is waiting for us.

To the expansive power of Commerce, to the invitation of Opportunity, to the call of the Future upon the action of To-day we have to reply in large measure, "No ships," and, again, "No ships."

To the constricting force of War Trade and War Industries is added the constricting power of No Ships. America fighting for Freedom seeks herself to be free, but has not Liberty at sea for lack of ships.

It is up to the Shipping Board, first, that the army shall have its fill of men and food and munitions, and then, may it come speedily, that there may be freedom of the seas for American Commerce to neutral lands, there to trade with those whose trade we need for the coming Future and from whose trade we are now excluded by No Ships.

The ultimate task, then, beyond the immediate one, is to set the Commerce of America free.

HOPE OF WAR LIES IN OUR SHIPBUILDING INDUSTRY

WILLIAM B. WILSON, SECRETARY OF LABOR

The programme outlined by Edward N. Hurley, Chairman of the United States Shipping Board, means that a very large number of men must be found who are capable of supplying labor. The finding of the right men for these jobs will be the very foundation of the success of this programme, since the building must be prompt. Faithful, steady, conscientious workers must be discovered and turned over to the shipbuilding industry without delay. The hope of the war depends upon this.

Therefore, Mr. Hurley's programme means much to the Department of Labor. Taking the chairman's own figures—that 130 plants in 28 States on both coasts and the Great Lakes are now engaged in shipbuilding, and that more than one-half of these have been developed in two years—it may be seen that the National Department of Labor Employment Service has a tremendous task to perform. The employment exchanges in the various States are working day and night.

Mr. Hurley tells us that he will need for this work 4,000 new men a week until he has placed 400,000 laborers in the shipyards on the coasts and lakes of the country.

To get these men, nearly every industry must contribute, for the shipyards must use the ability of skilled mechanics, artisans, blacksmiths, pattern makers, laborers in erecting, bolting, drilling, riveting, chipping, galvanizing, drop forging, etc. A ship requires all kinds of labor—from the very technical "tailoring in steel" to ditch digging in the shipyards. In order to build ships, twenty trades must be used. There must be an enormous educational programme, giving thousands of men their first highly specialized knowledge. There is much that is big and hopeful about this; much that is of permanent constructive value. It will mean the organization of growing towns, the building of morale which should be the finest in the world, the establishment of facilities under Government control which should result in stabilizing conditions.

With such inspiration, any laborer in the United States will be eager to give his best service. There can be found no greater loyalty nor more sincere patriotism than the American laborer feels.

INCREASED TONNAGE WILL ENHANCE INTER-RELATION OF COMMERCE THROUGH MAIL FACILITIES

A. S. BURLESON, POSTMASTER GENERAL

In regard to the transportation of the mails to foreign points, the service is restricted, except to Canada and Mexico, to the means provided by shipping, and without shipping the United States would be isolated from the rest of the world and bound to other countries only by wires under the ocean and by electrical currents used in transmitting radio messages.

In the maintenance of the foreign mail service, shipping is an absolute necessity, and, with the withdrawals of mercantile vessels for use in the Navy Department in the transportation of troops overseas, or for the now highly lucrative employment of freight carrying, the mail service has suffered and will continue to suffer unless the United States Shipping Board comes to its relief with the vessels that are under the control of that Board or being built under its supervision. There appears to be no good reason why vessels of the Shipping Board that carry freight may not also carry mails, and the closest co-operation is hoped for between the Board and the Post Office Department, in order that the extension of the mail service may grow apace with the extension of the activities of the Board.

Commercial interests in the United States suffer whenever there is a lack of mail facilities, and, with shipping

under the control of the United States authorities ample enough to take the place of the vessels of other nations withdrawn for war work, the extension of commercial intercourse with the United States will be increased and strengthened, so as to guard against reduction in the future, no matter how great the opportunities offered by foreign bottoms after hostilities cease. At this time the Department is availing itself of the opportunities afforded by naval vessels to carry mails to foreign ports to which there is a lack of carriers of other kinds, and the addition of vessels of the Shipping Board will surely give the United States the advantage in mail transportation which at no other time has the service enjoyed.

Parcel post to Belgium, Denmark, Greece, Liberia, the Netherlands, Norway and Sweden was suspended because there were no steamships available to carry the mails direct from the United States to the respective countries, as the parcel post service is restricted to vessels which land mails in the country to which they are directed, and not at some intermediate country for onward transmission. Sixty years ago it was considered good service when one vessel a week reached New York with mails from Europe, yet, quite recently, for one week not a mail vessel came into the harbor from a European port.

In regard to the transportation of the mails between domestic ports, service by steamboat has heretofore been provided under contract awarded upon advertising for proposals. On the larger lines there has been practically no competition, resulting in the payment of high rates by the Department for the transportation of the mails. Domestic service includes that between the United States proper and Porto Rico, Hawaii and Alaska, as well as the service on the water routes within the States. However, under recent legislation, this Department has ordered the carrying of the mails to Alaska and Hawaii as freight or express. If the Shipping Board constructs and operates vessels on which the mails can be carried on domestic routes, the Government will receive the advantage of having the mails carried at actual cost. Furthermore, the mail service could be considered in arranging schedules on the steamship lines, and thus improved service be afforded to all the world.

SHIPS OF OUR NEW MERCHANT MARINE HAVE DEEP SIGNIFICANCE

JOSEPHUS DANIELS, SECRETARY OF THE NAVY

The chief business of the navy so far during this war has been to keep safe the road to France. This work has been well done, due to the skill, knowledge and courage of the men who man our fighting ships. But capable as has been the overseas transport service, brave and courageous as our soldiers and marines who are winning victories in France, the vital need has been ships and ships and more ships to carry our fighting men, munitions and supplies. We need more, and every man who drives two rivets where one has been driven before is a public benefactor. More than that; he belongs to the mighty army which is preserving liberty for the men of our day and for the man of future generations.

All honor to the men who have expedited shipbuilding, who in freezing weather and in burning heat have heeded the naval signal "full speed ahead" in building ships. And all honor, too, to those who, in this supreme hour, are putting on additional steam in this patriotic service. They are as truly doing their part to win the war as are the men on the ships and in the trenches.

SHIPS WILL MAKE AMERICA SELF-SUFFICIENT

FRANKLIN K. LANE, SECRETARY OF THE INTERIOR

Ships mean to us the development of the minerals of the United States, instead of their importation from foreign countries, through ready availability, making America self-sufficient industrially.

Control of Hull Construction of a 5,000-Ton Deadweight Fabricated Steel Ship

Methods and Practices Required at Yards in Ordering Material to Facilitate Deliveries from the Steel Mills

BY FABRICATOR

It is desirable that the material schedules covering steel requirements should be gotten out under the supervision of a man who is familiar with steel mill methods and practices. The mills themselves, as we well know, are very thoroughly organized, with a single specialty—that of producing steel—and to meet the foibles of a naval architect is all very well if the order does not interfere with the output in doing so. Usually, however, what a buyer wants is steel rather than a willingness on the part of the manufacturer to oblige.

Steel is the most important element of a steel vessel, and its source and production are given so little consideration that it is probable that the output of our steel mills would reach their one hundred percent rated capacity if the men responsible for steel purchases in shipyards and elsewhere would get out and get together and get acquainted. Incidentally, in this respect, their own organizations would brighten up.

A buyer will save time both for himself and the steel mill by meeting the requirements of the methods in

practice which are generally to be found in the various mills. In fact, the majority of the details are standardized to an extent that makes this quite easy, since there are really not so very many types of mills to confuse the shipbuilders. In general, steel mills are classified as bar mills, shape mills, plate mills, and so on, with these further sub-divided, certain mills specializing only in merchant bars, others in standard lightweight angles and channels, still others in heavy and special angles and channels, I and H beams, universal mill and sheared plate, and a few in armor plate.

Until recently there were only two or three mills rolling bulb angles, ship channels and deep beams, all of which are used almost exclusively in shipbuilding. Yet there were many mills rolling standard and structural angles, channels and beams—hence the "standard" fabricated steel ship—and the mills engaged in rolling bulbs, Z-bars, etc., were undoubtedly glad to drop them and take up standard shapes. Even to-day there is only one mill in the country rolling a certain deep I-beam very desirable as a foundation element, and an H-section which is used for pillars. Z-bars have been dropped altogether.

With the exception of the plate mills, a set of rolls will produce only one size section, and to change the rolls means putting out of service that particular mill and probably the "blooming" mill also, with a disturbance of mill processes all the way back to the soaking pits.

Mill Rolling Schedules

"Tonnage" the mill must have. That means that it must have orders that enable it to run a maximum length of time before changing rolls and disturbing processes. The mills control their output more positively by means of their "rolling schedules," which cover periods of from one week in the larger mills to semi-monthly and monthly periods in the smaller mills. They go over their orders regularly and accumulate all of the tonnage possible in a minimum number of sections and sizes which will keep their equipment running to full capacity with the fewest disturbances. The common sizes and sections in greatest demand usually receive a preference. They are easier to get, are in the schedules oftener, and the larger the order in weight and the fewer the number of items on it for that particular weight, the better the chances for early delivery, particularly if a man was slow in getting in his order.

It is well to avoid small lots of odd sizes. It would be better to make substitutes when at all practicable, or else get a heavier section or even change the design. An order for a small lot of a few hundred pounds should be purchased from warehouse stock. As a rule, warehouses have an excellent line over quite a range of shapes and sizes, and they can make shipment probably the day the order is received.

When sending an order to the mill, let it be clearly understood that the mill people must have from ten days to two weeks in order to work the order through the sales office, the order department and into the mill schedules. If the mill is a large organization, it should be permitted one or two weeks in which to roll; if it is a small one, it should be given from two to six weeks in which to roll, and, in the case of both, an additional week in which to load. A mill cannot be expected to make complete shipment of the order at one time if the order covers a wide range of sizes and sections. Even in the minimum time, two or three weeks should be allowed for grace and safety. Nor can it be expected that a mill will put any more marks on material than is absolutely necessary. The order number, with perhaps the hull number, should be sufficient guidance for the mill shipping clerk and the receiving clerk. It would be better to let the items go through with the regulation shipping marks, since the receiving clerk must check the dimensions of each item, anyway, at which time also he may put on the required marks. The marks used by shipyards ordinarily are very undesirable.

Except in a few special instances of extreme length or a few odd items of special heavy sections, buy bars, angles and channels in random lengths, or else in a range of lengths not varying more than from 20 to 30 feet. Do not bother with multiples, but buy all of one size at once. Such scrap as remains will be more serviceable and in no greater quantity than if the material had been ordered to lengths, owing to the fact that the mill cutting tolerances necessitate trimming anyway.

An order for sheared plates should be grouped by gage or thickness first and then by width; the length, of course, is immaterial. Universal mill plates should be grouped by width first and then by thickness. This grouping, however, should not be followed when ordering; it is done here to facilitate getting all gages and widths together, and to facilitate ordering. Sketch plates and circles are to be avoided in shipyard specifications. The scrap from rectangles will be used for fillers, washers, plugs, etc.

How to Order

It is well to give the mill the option of furnishing either universal mill or sheared plates and to order multiples in width and length whenever possible. When ordering multiples in width, however, see that the cutting widths are given in order that the mill may furnish narrower plates than those ordered; that is, if it should prove possible to gain time.

In ordering bars, plates and shapes, avoid lengths over 30 feet. They are very difficult to handle and to keep straight, and also require an extra car or "idler" when being transported, due to the overhang, since our freight cars average 36 to 40 feet overall. If longer items are necessary, get them all into the mill together.

Due to the jolting during transportation, items in the carload will tend to shift, which may necessitate stopping the car to re-load. Material 30 feet in length permits of a margin for this purpose. In the case of "idlers," the items have to be loaded so that the cars will take curves freely, and, because the loads cannot be made secure, the tendency to shift about is very great. A double load will rarely reach its destination without having been "shopped" at least once, due to shifted material, which will mean a delay of from one to two weeks in delivery.

Beams and channels should be ordered by expressing the depth and flange in inches, the weight per foot and the length in feet and inches.

Angles and bulbs should specify the legs—the longest one first, if unequal—in inches; the weight per foot and the length in feet and inches.

Bars, rounds, squares, etc., should specify width and thickness in inches and the length in feet and inches. In this connection it is well to remember that any item up to and including 6 inches wide is a bar; over 6 inches a plate.

Sheared plates should be ordered length, width and gage in inches, and universal mill plates ordered length in feet and inches, and width and gage in inches.

Following Standard Practice

In each of the foregoing cases, dimensions should appear on the order in the sequence given. This will meet the requirements of standard practice, and if similar sizes and plates are grouped so that a plate mill gets nothing but sheared plates on one schedule, and these in distinct groups distinguished by gages, and your angles and chan-

nels, etc., are all gotten out in a similar manner, you can be certain that your order will get very good consideration by the mill and, what is more to the point, quicker delivery.

It is well to make sure that deliveries asked for on orders meet the requirements. If the shipping schedules are properly gotten out there will be no uncertainty. Yet if one is caught short on an item it would be better to try for warehouse stores before endeavoring to break into a mill schedule. With the very best intentions, a mill may promise to put an item into a current schedule, but in most cases it will fall down sadly in making the promise good. Every person in the steel material section of a yard should be familiar in a general way with steel mill classifications and description and cutting variations. This is hardly the case, though, and Table A, covering standard dimensions and items, and Table B, covering cutting variations, should be of value in helping to bring this condition about. On occasion now and again one has use for a few sheets and light plates. Tables C and D are therefore included.

TABLE A.—STEEL MILL STANDARD PRODUCT

Description	*Minimum and Maximum Dimensions*
Bars	
Rounds and squares	3/16 inch to 7¼ inches.
Ovals	⅜ inch to 1¾ inches.
Hexagons	5/16 inch to 2½ inches.
Half ovals and half rounds	5/16 inch by 5/32 inch and less to 4 inches by 7/32 inch and over.
Flat bars and heavy bands	⅜ inch by ¼ inch to 6 inches by 4 inches.
Light bars and bands	⅜ inch by No. 12 and ⅛ inch to 6 inches by No. 7 and 3/16 inch.
Shapes	
Equal angles	½ inch by ½ inch by ⅛ inch to 8 inches by 8 inches by 1⅛ inches.
Unequal angles	1½ inches by 1¼ inches by 3/16 inch to 8 inches by 6 inches by 1 inch.
Bulb angles	4 inches by 3½ inches by 11.9 pounds to 10 inches by 3½ inches by 32.0 pounds.
Bulb beams	6 inches by 4⅜ inches by 14.0 pounds to 10 inches by 5½ inches by 36.6 pounds.
H-beams	4 inches by 4 inches by 13.6 pounds to 8 inches by 8 inches by 34.0 pounds.
Structural beams	3 inches by 2⅜ inches by 5.5 pounds to 27 inches by 7.5 by 83.0 pounds.
Structural channels	3 inches by 1.4 inches by 4 pounds to 15 inches by 3⅞ inches by 55 pounds.
Equal tees	1 inch by 1 inch by 0.89 pound to 4 inches by 4 inches by 13.5 pounds.
Unequal tees	1¼ inches by ⅝ inch by 0.88 pound to 4 inches by 5 inches by 15.3 pounds and 5 inches by 3 inches by 13.4 pounds.
Plates	
Universal mill	From ¼ inch to 2 inches thick by 6½ inches to 48 inches wide and from 30 to 100 feet long.
Sheared	From ¼ inch to 2¼ inches thick by 24 inches to 132 inches wide and 132 to 560 inches long.

TABLE B.—STANDARD CUTTING VARIATIONS

Beams and channels	⅜ inch over to ⅜ inch under
Angles and other shapes	¾ inch over to 0 inch under
Universal plates, length	¾ inch over to 0 inch under
Sheared plates, length and width	¼ inch over to ¼ inch under

TABLE C.—STANDARD WIDTHS AND LENGTHS OF STEEL SHEETS, BLACK OR GALVANIZED

Gage	*Widths*	*Lengths*
No. 10 to No. 30	24 inches to 36 inches	72 inches to 120 inches

TABLE D.—STANDARD LIGHT STEEL PLATES

Gage	*Widths*	*Lengths*
3/16 inch	24 inches to 74 inches	200 inches to 360 inches
No. 8	24 inches to 72 inches	200 inches to 290 inches
No. 9	24 inches to 70 inches	160 inches to 250 inches
No. 10	24 inches to 68 inches	140 inches to 230 inches
⅛ inch	24 inches to 66 inches	140 inches to 200 inches

(*To be continued.*)

Many men will see a thing for years and not understand or appreciate it, as, for instance, why it is that the sunlight coming through small openings always makes a round or oval spot of light on the floor.

Annual Meeting of Society of Naval Architects and Marine Engineers to be Held in Philadelphia

The twenty-sixth general meeting of the Society of Naval Architects and Marine Engineers will be held in Witherspoon Hall, Philadelphia, Pa., located at Walnut and Sansom streets, Thursday and Friday, November 14 and 15, and will begin at 10 A. M. each day.

The annual banquet will be in the Grand Ball Room of the Bellevue-Stratford at 7 P. M. Friday, November 15.

The Council will meet at 3 P. M. Wednesday, November 13, in the office of the secretary-treasurer, Daniel H. Cox, U. S. Shipping Board Building, 140 North Broad street, Philadelphia.

Applications for membership should be mailed so as to reach the secretary on or before November 13.

LIST OF PAPERS

"Revival of Wooden Shipbuilding as a War Emergency," by Carlos deZafro.

"Floating Dry Docks," by Charles N. Crowell.

"On Vibrations of Beams of Variable Cross Section," by N. W. Akimoff.

"Notes on Progress in Turbine Ship Propulsion," by Francis Hodgkinson.

"Structural Steel Standardized Cargo Vessels," by Henry R. Sutphen.

"Notes on Launching," by William Gatewood.

"Side Launching," by Frank E. Kirby, honorary vice-president, and Edward Hopkins.

"Experiments Upon Simplified Forms," by Professor H. C. Sadler.

"Standardization of Ships," by A. J. C. Robertson.

"Variation of Shaft Horsepower, Propeller Revolutions and Propulsive Coefficient with Longitudinal Position of the Parallel Middle Body in a Single Screw Cargo Ship," by Naval Constructor William McEntee, U. S. N.

"Recent Developments in Shipyard Plants," by Naval Constructor Sidney M. Henry, U. S. N.

"Concrete Ships," by R. J. Wig.

"The Application of Electric Welding to Ship Construction," by H. Jasper Cox.

"Hog Island—The Greatest Shipyard in the World," by W. H. Blood, Jr.

A young man began his apprenticeship in a pattern maker's shop. One day the boss gave him a hook and screw eye and told him to put the hook on a closet door. When the job was done the boss looked at it and said: "Son, you should have put the screw eye on the door and its hook on the jamb, where the hook would not knock the paint off the door when it swings." The young man answered, "You told me to put the hook on the door and I followed your instructions."

Did the young man do right, or was the boss at fault?

Air and water fluids. In compressing air very small clearances are necessary, as air is elastic. In pumping water, clearances need not be small or even taken into account, as water is non-compressible.

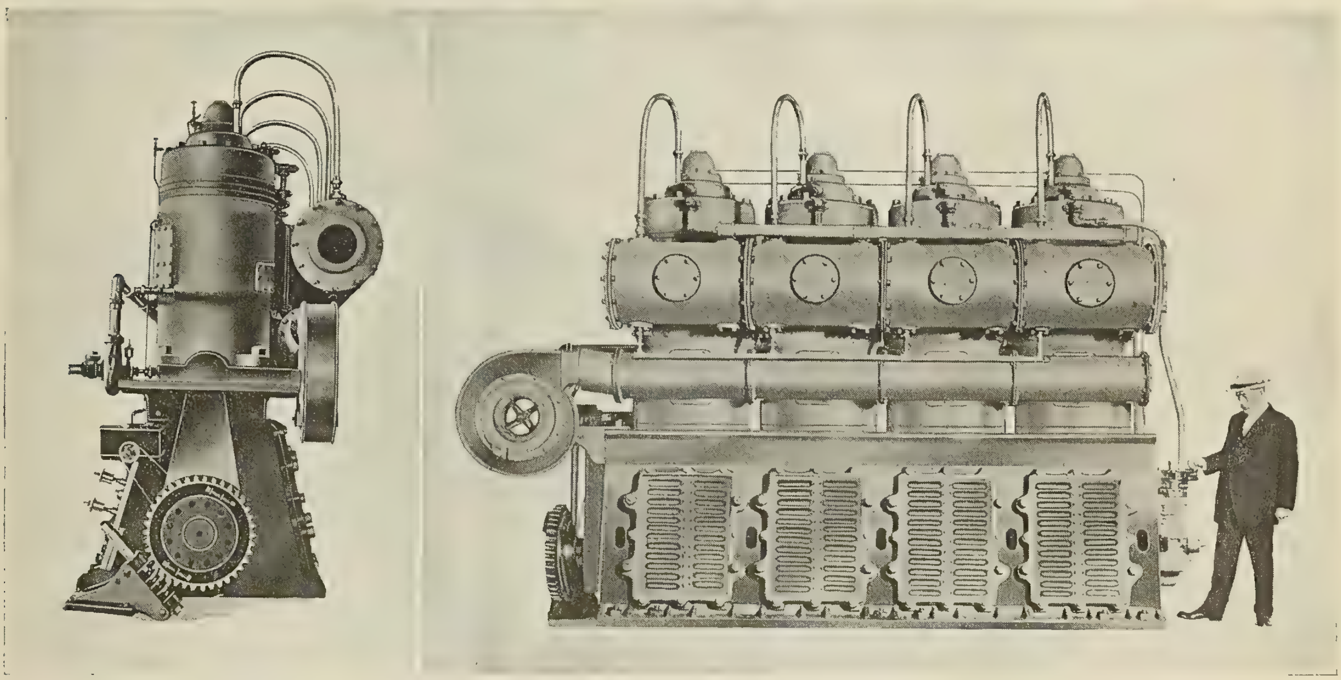
Someone has said that a path would be worn to the door of a house in which lived a man who knew more about a certain subject than anybody else in the world. That may be true, but the trouble lies in the fact that the world is slow in finding out a man's knowledge until after he is dead.

The surface blow in a boiler is, in fact, a skimmer removing all that floats; the bottom blow is a remover of sediment or anything that does not float. Both foreign materials are a detriment to a boiler. Get them out as soon as possible.

New Type of Marine Oil Engine

Two-Cycle Engine With Some Novel Features—A Simple Injection System — Subject of Scavenging Discussed

MR. CARL W. WEISS, associated with the Metz & Weiss Engine Company for a number of years and now connected with the Weiss Engine Company, 17 Battery Place, New York, has developed a surface-ignition, medium-compression, two-cycle oil engine that promises to widen the scope of the heavy oil motor. The engine illustrated herewith is a 400-brake horsepower, 4-cylinder unit, although the type is also being built with six and eight cylinders. Among other features it possesses a new method of scavenging, and, in this connection, when it is recalled that the ordinary type of surface-ignition, medium-compression oil engine uses a baffle plate in conjunction with crank case compression for scavenging—a construction which, due to uneven thicknesses of metal, makes for uneven contraction and expansion that frequently results in cracked piston heads—it is well to note that in the accompanying illustration the piston is conical in shape and a rather wide departure from usual practice.



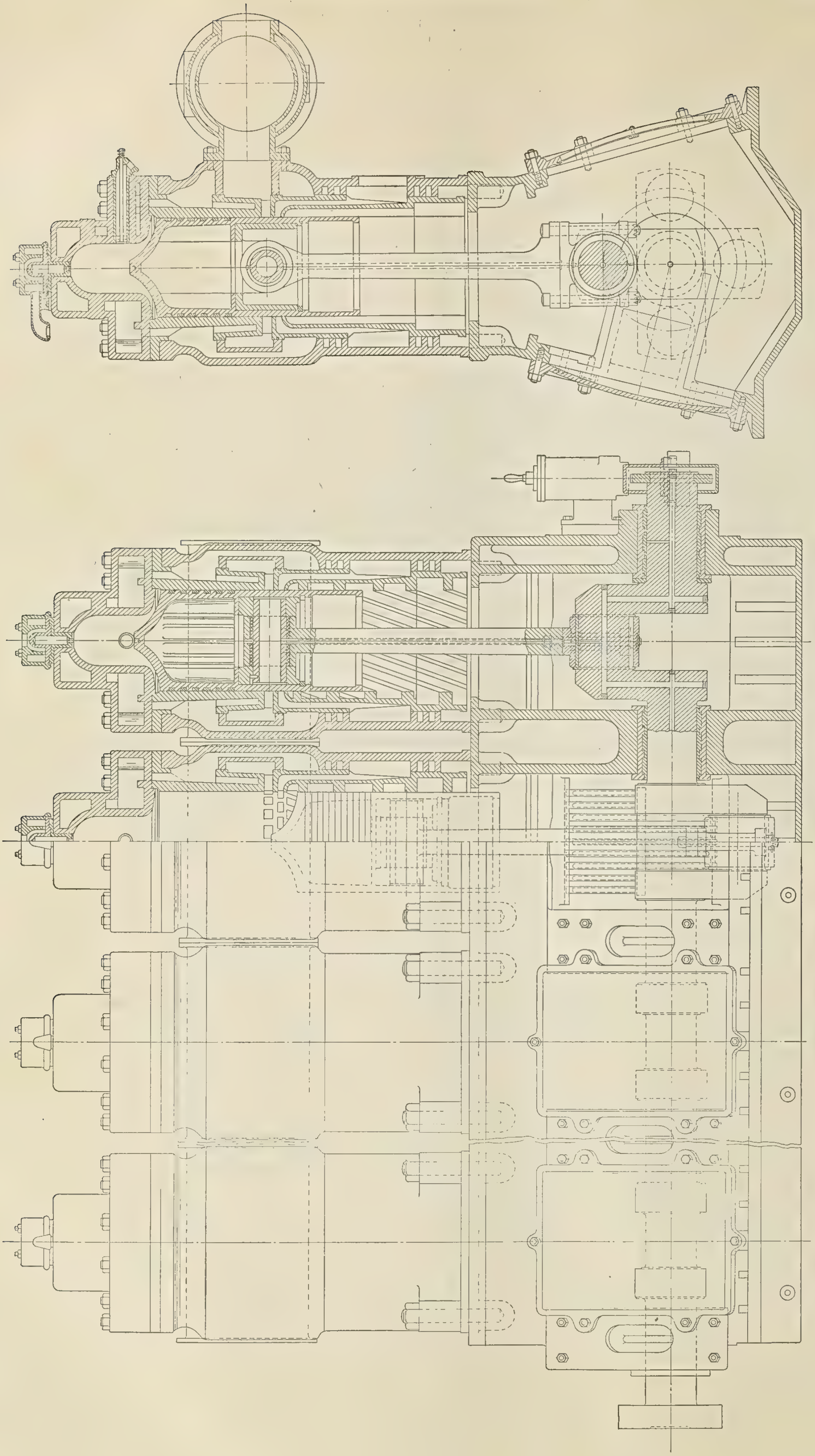
End View and Side View of Weiss Engine

Bone of Contention

The bone of contention regarding the relative efficiency of the surface-ignition, medium-compression, two-cycle oil engine has always been the matter of scavenging. That previous existing types of this style engine have not completely burned their charge or completely cleared the cylinder of burned gases after each explosion has been the contention. In the engine here shown there has been incorporated an entirely new method of scavenging. There are three annular sets of piston controlled ports: (1) the exhaust, (2) the supplementary, and (3) the crank case port. The supplementary ports are open to either atmospheric or under low pressure of air supplied (as in this instance, see illustration) by a small pressure blower. As the piston uncovers the first series—the exhaust ports—near the end of the expansion stroke, the pressure of the cylinder drops to atmosphere, and, due to the abrupt discharge and the forcible cooling of the gases, the pressure at once goes down to several points below atmosphere. At this point the supplementary ports open, allowing a charge of pure air to sweep in radially over the conical piston head, displacing the exhaust gases left in the cylinder, while immediately following this, as the crank moves through the lower dead center, the crank case air under approximately five pounds pressure per square inch also flows in over the conical piston head by way of the annular series of ports formed by the spirally ribbed lower parts of the cylinder liner. In this way three completely separate and distinct charges of air are introduced into the cylinder during the scavenging process, which, undoubtedly, accounts for the fuel efficiency of this new type and its ability to operate indefinitely without undue heating of piston head.

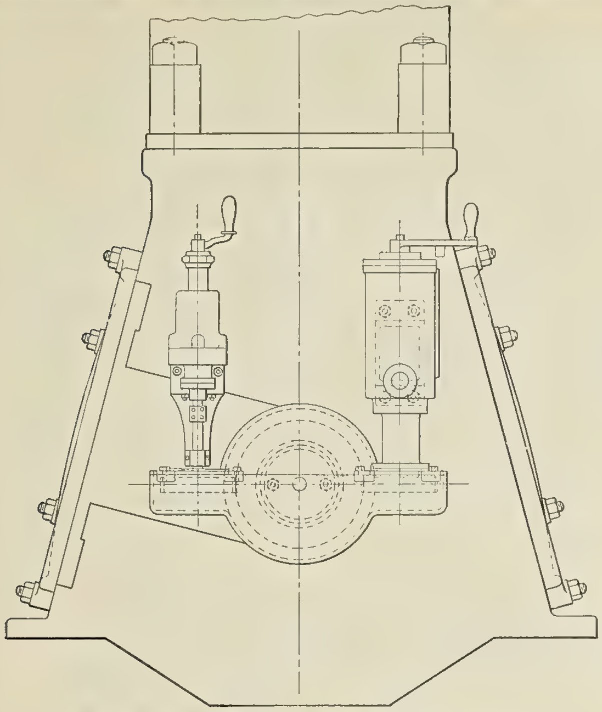
Simple Oil Injection System

The oil injection system of this multi-cylinder engine is simple. In place of direct-driven governor control injection pumps, there is an independent duplex pump to keep the oil under constant high pressure, and a compensating distributor valve, driven from the engine shaft, arranged for timing adjustment for different grades of oil and either direction of rotation. This pump is connected to the air receiver used for starting and reversing the engine. With a normal air pressure of 200 pounds in the receiver, the oil pressure is kept at 1,000 pounds by a reducing valve in the air line. Heavy oils require high pressures for efficient spraying. The governor is designed to act directly on the compensating valve and is, in fact, carried by the distributor valve and submerged.



Elevation and Cross Section of Weiss Engine, Showing Conical Piston and Cylinder Liner, Together With Method of Supporting Main Bearings from Side

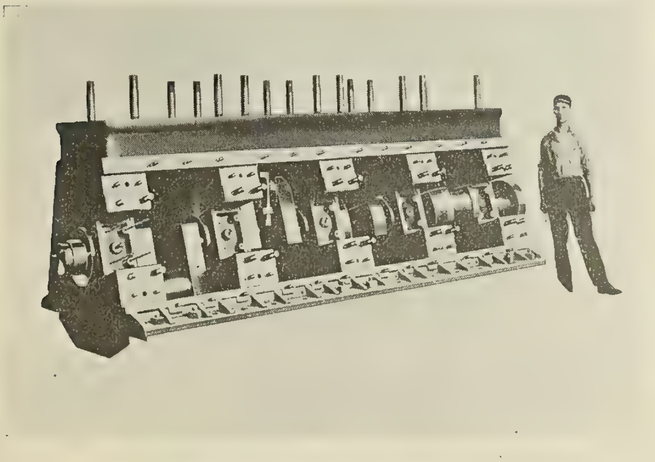
There is a spiral gear mounted on the front end of the crank shaft which drives the oil distributor on one side and the air distributor for starting and reversing on the other. Each cylinder has an air check valve piped to the air distributor and a relief valve open to the atmosphere. These relief valves can be operated either independently or simultaneously by a lever at the front end of the engine,



End Elevation, Showing Oil Distributor Valve

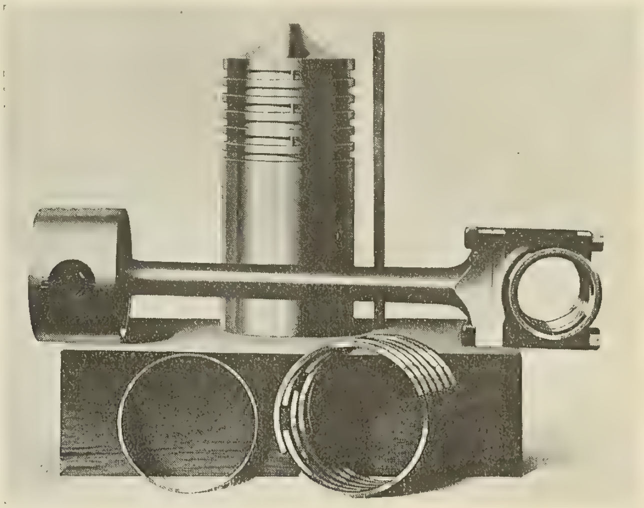
so that the entire control of speed, starting and reversing, and pressure relief is brought within easy access of the engineer.

Forced feed lubrication is used for the cylinder, main bearings, crank pin and wrist pin, each pipe terminal fitted with a lubricating sight check. These lubricators are of the single plunger, distributor disk type, furnished by L. T. Weiss, of Brooklyn, and used in large quantities by the United States Government on single- and multi-cylinder engines and guaranteed to force oil against 200 pounds



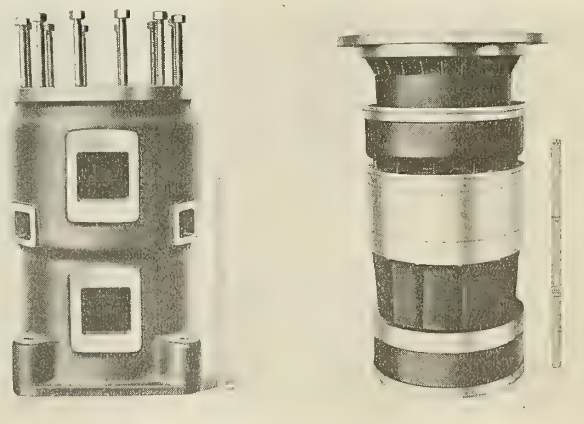
View of Crankcase and Shaft

pressure. The illustration shows an eight feed circle mechanism. A hardened steel worm engages a worm wheel disk, which latter carries a steel plunger with its operating yoke. As the check turns, the two diametrically opposite projections of the yoke and the fixed star wheel operate as an escapement, reciprocating the plunger, to draw in and discharge oil through a hole in the disk, registering alternately with the suction and discharge hole in the base. Each discharge has a screw coupling for copper tubing. The whole mechanism being very simple and substantial, and submerged in oil, with an extremely slow movement, these lubricators run for many years without the least wear or adjustment.



Piston, Piston Rings and Connecting Rod

This type of marine engine requires no fly wheel and no special scavenging pumps. The weight per horsepower is reduced to approximately 150 pounds without sacrificing a reliable factor of safety within the limits of working pressure. At a pressure of 500 pounds per square inch the maximum main bearing pressure does not exceed 509 pounds per square inch projected area. The shaft in the 16½ by 22 unit is 8¼ inches diameter. The bearing length is 12¾ inches. There is a center bearing between each cylinder in the multi-cylinder type. The bearing pressure, therefore, is 500 × 214 = 107,000, divided by 210 = 509 pounds, as stated above, while the mean pressure is below 100 pounds per square inch projected area. The mean crank pin pressure equals 290 pounds per inch projected area. The connecting rod being five crank lengths, the side thrust at crank circle tangent is below 40 pounds per



Cylinder and Cylinder Liner

square inch projected area. The piston is 16½ inches diameter and 33 inches in length, giving a projected area of 33 × 16½ = 544 square inches. The mean wrist pin pressure averages 475 pounds per inch. The size of the wrist pin is 5½ × 8¼ = 45.37 square inches projected area.

Referring back again to lubrication, which undoubtedly is one of the most important features of any engine of this type, it should be noticed that this engine uses a pressure system very similar to that adopted by high speed gasoline engines. The shaft is drilled all the way along the main bearings, crank cheeks and crank pins, with an outlet at each bearing and crank pin, so that with oil under pressure connected to the end of the crank shaft all bearings are flooded with oil and the wrist pin receives its lubrication from the crank pin through a hole in the connecting rod, provided with a check rod running the entire length of the hollow connecting rod. When the engine is in operation this rod plays about one-eighth of an inch between the wrist pin and the crank box for the purpose of checking the oil which has once passed the rod, and retaining same for wrist pin lubrication. With this pressure system there is really no need for a special check rod for the oil in the connecting rod, but this provision is of considerable advantage, inasmuch as there is no oil in the rod when the engine has been standing for a sufficient time to enable the oil to leak out. With the oil in the rod the wrist pin will get its lubrication right from the start, and this prevents any cutting of the bronze bushing which bears against the steel-hardened and ground wrist pin. In the customary way of putting the wrist pin directly through the piston, usually cast with heavy bosses on each side, the chances of conducting heat to the wrist pin are much greater than in the wrist pin carrier arrangement used in this engine.

Particular attention is drawn to the illustration showing the conical piston with its even thickness of metal, to the connecting rod, to the piston pin carrier and to the piston pin, where it will be noted that the wrist pin is mounted in a separate carrier which is locked inside of the piston by means of a snap ring, thus dispensing with the ordinary piston construction calling for heavy bosses on the body of the piston. Inasmuch as there is less heat conducted with the arrangement here shown, the lubrication of the wrist pin and durability of it is materially increased. The heat flowing from the piston wall to the wrist pin in the other style of engine necessarily makes the lubricating oil very thin, and when the engine is shut down and the lubricating oil feeds ceased, the pin becomes practically dry. Later, when the engine is started, there is a very good chance of trouble, because it takes several minutes before the oil can reach the pin. In the design of wrist pin carrier here set forth, the temperature is lowered and, with a check rod in the connecting rod, the lubricating oil is kept at a level which will provide lubrication for the pin immediately with the starting of the engine.

An Appeal to Americans

Chairman Hurley Looks Into the Future—Appeals to Manufacturers — Cause of the Ruin of Old Mercantile Marine

BY EDWARD N. HURLEY*

THE time has come for Americans everywhere to put themselves solidly behind American ships.

Our railroads must no longer stop at the ocean. We are building an American merchant fleet of twenty-five million tons—three thousand ships. We are backing modern ships with modern port facilities, establishing our bunkering stations all over the globe and will operate with American railroad efficiency. We will carry American cargoes at rates corresponding to our railroad rates—the cheapest in the world. Fast American passenger and cargo liners will run regularly to every port in Latin America, the Orient, Africa, Australia.

Are you taking steps to use these ships to increase your own prosperity? Do you realize that American products of factory, farm and mine can be delivered to customers in foreign countries on terms which will build lasting trade?

Do you realize the possibilities for bringing back raw materials to extend your products and trade?

We must all take off our coats and work to bring the subject of these American ships home to the people of every American interest and community. The manufacturer must think of customers in Latin America as being as accessible as those in the next State. The farmer must visualize ships carrying his wheat, cotton, breeding animals, dairy products and fruit to new world markets. The American boy must think of ships and foreign countries when he chooses a calling.

Has your organization appointed a live committee on merchant marine?

Is the chairman of this committee a man of international vision?

Are you applying the new world visions to the interests represented in your organization and learning what ships can do toward widening your markets?

These are your ships. It is your duty to bring them close, regard them as new railroads, spread knowledge about them through investigations, meetings, discussion.

Public neglect ruined our old mercantile marine. Congress was not to blame—it simply reflected the indifference towards ships of the average American. Once more we have a real American merchant fleet under way, backed by far-reaching policies for efficient operation. We must dispel indifference and keep our flag on the trade routes of the world. We are going to take trade from no other nation. But we must serve our own customers and help other nations in their ocean transportation problems after the war.

I want to hear personally from your organization. These are precious days of opportunity. The nation is united for teamwork and service. Let us "Wake Up, America!"—which means waking up any suggestion that you think will be helpful in our work.

* Chairman of the United States Shipping Board.

The flat top and bottom of the U. S. standard thread is produced by simply grinding off a certain amount of the point of the thread tool. The theory of the round top and bottom is that the corners of the tap will wear off, anyway, after a little use, and you had better do this when making the tap. However, the trouble with the theory is that the flat topped tap stands up well and gives no trouble in practice.

Co-operative Management—The Apprentice

The Apprentice a Vital Essential in Industry—Should Be Given Liberal Education—Freedom of the Shop Important to His Rounded Education

BY ARTHUR F. JOHNSON

AS is the case in solving all complicated problems, the method of procedure embraces a general review of the whole, followed by the consideration of each successive detailed step beginning with fundamentals.

The initial factor of the human element, as concerned with co-operative management, is the apprentice boy, the future laborer, mechanic, foreman, outside superintendent and possibly manager, depending upon his individual ability, effort and the degree to which these two traits are given encouragement and recognition. Being an apprentice boy, in all probability he is the son of a mechanic, very rarely of a clerical yard employee, since that invisible wall between white collar and blue jeans would render an office boy's station more desirable in the eyes of the clerical parent. Boys being what they are, it is usually the parents' influence which determines their initial step as wage earners, together with their frame of mind toward the work to be undertaken and the officials and working conditions in the yard where first employed.

Home Environment Important

Take first the apprentice's early boyhood and home life as affected by the firm employing his father and his father's attitude toward the firm. If the father has been fairly industrious, sober and steady, has not neglected his family and still never advanced beyond the ordinary mechanic's station except to be recognized as a "good lathe hand" or a "fine mechanic," he will serve as an example of the great mass in the laboring classes. The boy has seen the father come home contented or disgusted, has heard the conversations concerning the work, the firm and the workmen's grievances (real or imaginary), has seen the wasted lifetime with little advancement and no savings or with something accumulated to have made it worth while, and is the typical all-around boy of fifteen, with a moderate fighting, swearing and mischievous ability. Given the opportunity, his showing with an advanced education would equal that of the average college graduate, but not having the means, nor perhaps the understanding of the value of education, he contents himself with going into the shipyard, there to pursue a trade. Possibly it is the identical one followed by his parent, but in any case the apprentice's knowledge of its possibilities is slight. He imagines that once equipped with a "trade," he is a finished man. Having at best completed a grammar school course, it is decided by family consultation that he'd better start "earning enough to buy his clothes." He goes to the yard, applies at the employment office, if such there is, and starts in by carrying water, scraping boilers or holding tools for a mechanic.

This is the point at which his opinion begins to be molded, and that at which the firm should take most active interest in his case. It is too often that apprentices are tolerated as necessary evils. Interest and application to a task vary in direct ratio to the extent in which effort is observed and appreciated. If the apprentice finds himself very unimportant, is given no systematic instruction, must content himself with brusque and often incorrect replies to his queries, there is every reason to anticipate poor progress on his part.

A well-organized apprentice system should be under the direction of a "supervisor of apprentices" chosen for his knowledge of the works, organization and ability to understand youths, discriminating in their employment. He should work harmoniously with the department heads and foremen of the branches in each department.

The duties of this supervisor would be original selection of apprentice candidates, their placing in the trade best adapted to their leanings, observation of conduct and recording the progress of apprentices, transfers into other branches if found desirable, promotions, settlements of grievances, discharges and supervision and administration of instruction.

Education and Credentials

The apprentice system proper would originate in the employment stage, candidates being received at stated periods only (say monthly), and being required to present statements as to education, credentials as to moral fitness and a personality subject to scrutiny of the supervisor. Applications would be submitted on a company form and filed, employment varying with demands of the plant. In this connection, co-operation with school authorities (grammar and trade) would afford most desirable material. Candidates would state their preference as to trade, but this would be subject to revision after the "visiting course" which would cover the first week of apprentice training. In this course a tour of the works would be made, one day being spent in each department in tracing the work from source to completion, explaining the relation and interdependability of departments and pointing out the duties and requirements for each trade involved. The apprentice would then be questioned and his preferences and fitness for particular trades noted. For example, he might prefer hull work, engine work, woodworking, pattern making, smith work, etc. If advisable, he would be started in the department desired, subject to transfer or discharge if proven inadept.

Detailed to a given department, the apprentice would serve for some two months in each branch of that department and under a different mechanic each week. His deportment, skill, originality and powers of observation would be noted and marked. At the end of a year, or subsequent to this inter-branch course, he would specialize for the remainder of his apprenticeship in the branch most suitable, as testified by his showing. Little selection being afforded by these, appointment would be governed by requirements of the plant with candidate's assent. At this point in the course the point should be made of allowing the apprentice full power of employing initiative, tempered, of course, at the discretion of the foreman in charge. No stated time would be required in apprenticeship. A minimum of one year's branch specialization with sufficient additional service to insure fitness as a mechanic would offer an opening for display of ability and prove an incentive to close study of the trade.

Times for Study

The practical instruction thus far outlined should be enhanced by an "instruction" course under direction of

qualified instructors from the drafting and planning sections, as well as the foremen from various shops. Apprentices would meet periodically on stated mornings for study of materials, machines, shop work and plant methods, blueprint reading, mathematics and mechanical drawing. Exceptionally bright individuals would be encouraged to prepare in spare hours for higher education and then enrolled in recognized technical schools through some method of loans or endowment.

Care should be exercised not to present too philanthropic advantages nor to require the students thus aided to obligate themselves too deeply. A service of three years subsequent to college graduation, with summer vacations additional, should absolve the youth from any feeling of indelicacy in seizing exceptional opportunities for advancement. Possibly one in fifty would show inclination for advanced education. The remaining apprentices would be rated mechanics through consultation between shop executives and the supervisor of apprentices.

Every encouragement to promote fellowship and athletics among these youths should be put forth. Athletic contests and even team contests with other works or between departments in a given plant would be excellent stimulus of morale.

The inauguration of a complete system as here outlined would require considerable thought and some expense. The idea is not novel, nor has it been untried, for the apprentice systems in Great Britain are arranged along the same general lines. Some of the features, notably those of social or athletic character, are in force in American plants, but the standardization of apprentice training has not yet received general consideration.

From the industry's standpoint, its adoption with modifications to suit particular establishments on the part of firms independently, would produce varied thoroughness in the training, resulting in somewhat better conditions than at present, but diversity in qualifications of the mechanics produced. If such training were adopted, the obvious necessity would be consultation between the various shipbuilding firms through a representative committee handling this and other labor matters. This committee should embrace skilled and trusted representatives of the trades in addition to firm executives, that the resulting apprentice system might prove most practicable and beneficial.

Apprentice training at present is so variable in thoroughness and degree of skill developed, it produces such a conglomeration of "mechanics" and has its standards fixed so wrongly by period of employment, rather than by learning assimilated during the period, that remedial measures should be instituted.

It is obviously improper for labor unions to set standards determining mechanical ability, not because they are incapable of doing this, but that the results attained are not always what they should be. Mechanical training in its different branches must be as nationally standardized as are the professions, that the industries may compete with certain and intense oppositions when industrial conditions resume their normal trend.

It is questionable whether opposition to such standardized training could be based on the grounds of expense and satisfaction given by the present system. Very probably the losses entailed through improperly and systematically trained labor are far in excess of the expenditures necessary for correction of this evil.

The Port of Seattle

A Terminal Harbor of Unusual Excellence—A Big Engineering Feat—Due to Growth of Overseas Commerce

BY CHARLES PHILIP NORTON

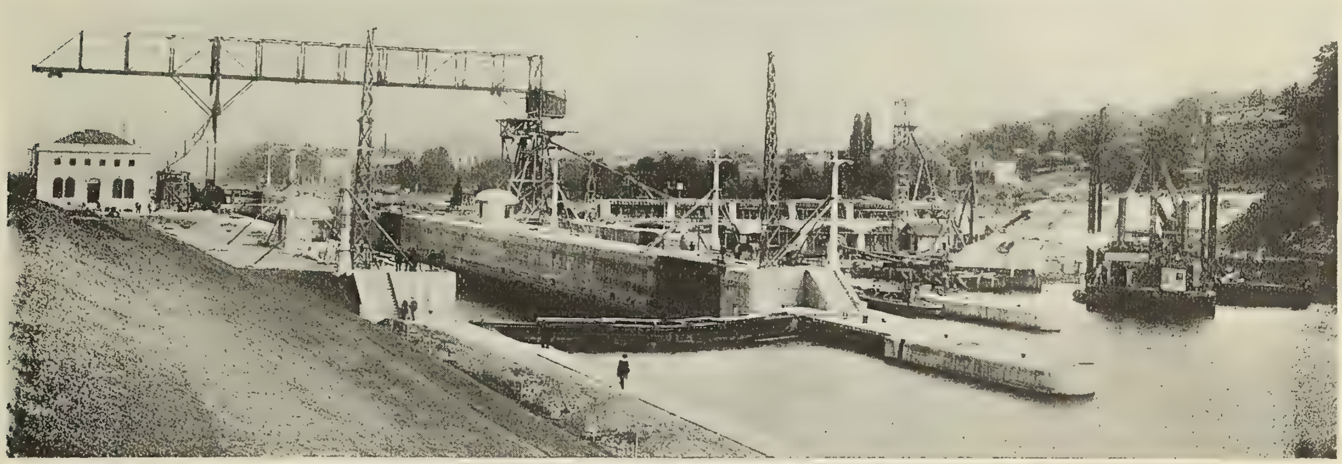
At the present time the harbor of Seattle includes fully 140 miles of deepwater shore front, but a small fraction of which has been occupied by harbor facilities and industrial establishments. Elliott Bay itself is practically landlocked and is consequently never subject to the destructive storms and heavy seas. Owing to this immunity, until within the last few years, the piers and terminals of Seattle were of quite simple and rough structural character.

To-day Seattle possesses several of as fine terminal establishments as modern harbor engineering has been able to conceive, and the total investment represented in their construction is considerably in excess of ten million dollars (£2,050,000). This includes the six magnificent piers and terminals built and operated by the Port of Seattle, built at a cost of more than $6,000,000 (£1,230,000), procured from the sale of bonds voted by the port district, which embraces Seattle and King county, under the management of three commissioners, elected by the people. The executive officer, appointed by the commission, is known as port manager, Hamilton Higday being the present incumbent of that office.

The astounding growth of Seattle's overseas commerce in the last decade, and particularly since the beginning of the world war, the volume of foreign trade having grown from a valuation of $59,031,495 (£12,100,000) in 1910 to $376,076,357 (£77,000,000) in 1917, and the number of trans-Pacific steamship lines out of Seattle having in the same time increased from three to sixteen, confirmed the wisdom of Port District development, which was completed just in time to supply, in large measure, the chief needs of this immense commerce, although even this large addition to harbor establishment has not been sufficient to adequately accommodate all the shipping offered for transshipment by rail or for export.

One of the unexpected developments of this trans-Pacific commerce has been the vast quantities of Oriental oils shipped through the port of Seattle, and for which there was not a proper terminal preparation, the oil-storage capacity, up to this time, being 12,500,000 gallons, with a delivering capacity of 1,000,000 gallons per hour. To meet this situation, Rogers Brown & Company has constructed one of the largest and most thoroughly equipped oil terminals in the United States, upon a site in the West Waterway, Seattle harbor. This terminal is designed specially for the accommodation of Oriental oils, and the tank storage capacity alone aggregates 1,000,000 gallons. The terminal is available directly

Seattle's Waterfront



Locks and Spillway from Salmon Bay, on Lake Washington Canal, Seattle

One of the Seattle Port Commission's Municipal Docks

to all ocean vessels and represents an investment of approximately $300,000 (£55,000).

By a careful survey of Seattle terminal facilities completed last year by the Transportation Bureau of the Seattle Chamber of Commerce and Commercial Club, which survey does not include data of later developments, such as the Union Pacific terminal, the following ascertained facts then existing are afforded for the consideration of those studying the extent of Seattle harbor improvements and their character:

Average depth of water at pier head line, extreme low tide, 25 to 42 feet.

Wharf Dimensions.—Total covered shed area, 2,500,000 square feet, 9,000,000 cubic feet; average floor load capacity, 600 pounds per square foot. Total outside area, 1,000,000 square feet; average floor load capacity, 500 pounds per square foot.

Pier Berth Room.—Number of 400-foot vessels which can be simultaneously accommodated loading or discharging, 100. Number of tons which can be loaded on such vessels per 24 hours under normal conditions: General merchandise, 60,000 tons; steel and heavy machinery, 50,000 tons; lumber, 6,500,000 feet board measure; grain, bulk, 10,000, sacked, 48,000 tons.

Storage Capacity—Merchandise.—Wharf shed, 250,000 tons; warehouse, 250,000 tons; open space, 200,000 tons. Waterside cold storage capacity, 35,000 tons. Waterside grain storage capacity, 100,000 tons; delivering capacity in tons per 24 hours, bulk grain, 8,000, sacked grain, 5,000. Storage capacity for steel and heavy machinery, wharf, 3,000, open space, 1,873.

Alaska Fishing Boats in Fresh Water Harbor, Lake Union, Seattle

Waterside Fuel Facilities.—Storage capacity in cars, 12,000; delivering capacity in tons per hour, 10,000. Oil storage capacity, 12,500,000 gallons, delivering capacity per hour, 1,000,000 gallons.

Mechanical Handling Equipment.—Modern, single lift capacity, locomotive cranes, 10 tons; gantry cranes, 5 tons; stiff-leg derricks, 15 tons; shear-leg derricks, 100 tons.

Dry Docks.—Six dry docks, combined lifting capacity, 50,000 tons.

Railroad Service.—Spur track capacity in cars, shipside, 500, landside, 1,100 cars.

Some Insufficiently Considered Details of Ship Construction and Equipment*

Analysis of Conditions of Yard Management—Details of Ship Equipment Criticized—Stresses on Cargo Gear

BY C. WALDIE CAIRNS, M.SC.

IT will be generally admitted that shipbuilding art and science have reached a fairly satisfactory position, though there must be possibilities not yet fully realized in the more efficient application both of labor and present materials towards the production of efficient vessels, and we hear more than rumors of new materials. No doubt, too, much useful information has yet to be obtained and disseminated as to the form best suited to any desired speed and deadweight, but in the main we may assert that the modern steamer generally "keeps right side up" and gets through the worst weather with fewer serious instances of strain either to upper works or to bottom than in the days when the registration societies were struggling with the problems arising from increase of size and of fulness of the ordinary cargo ship.

The writer has no intention in this contribution of invading the domains of the naval architect in any of the important provinces mentioned, but wishes to direct attention to a number of items which, from his experiences with shipbuilders and ships, he judges receive somewhat scant attention in the ordinary cargo steamer equipment.

It is not suggested that all shipbuilders neglect all the items mentioned. Attention to these details varies greatly. The practice regarding some of these is excellent in certain yards, but the writer has seen important items overlooked in yards that, in most respects, are at least up to date. None of the items referred to account for much in the total cost of a ship, but they may mean a great deal in relation to subsequent satisfaction, safe working, or freedom from irritating small repairs.

Certain of them might well be the subjects of standardizing agreements or of a standard fittings specification

* Read before the Northeast Coast Institution of Engineers and Shipbuilders, Newcastle-upon-Tyne.

which would eliminate a slight advantage in the market that a "mean" yard may hold over a yard where quality is considered.

Practice with regard to some fittings is not even sufficiently standardized in individual yards, choice of details being occasionally left to foremen, apparently without any standard arrangement to be complied with.

The necessary minimum scantlings and ground and mooring tackle are already imposed on builders in the rules of classification societies. It would be a convenience to owners of ships, and no doubt to builders also, if a well considered minimum standard in other details of equipment could be formulated, or even a series of grades of equipment which could be referred to by distinguishing titles. There might, for instance, be a minimum *Coasting Collier Equipment* or *Class* 1 and *Class* 2 *Coasting Collier Equipment*—similarly, one or more grades of *Baltic Trade Equipment,* of *Collier and Ore Trade Equipment,* of *River Plate Trade Equipment,* of *Eastern Trade Equipment.* Some of these would differ comparatively little in main features.

Possibly the commencement made by this institution on the North-East Coast Institution engine specification, which is already leading to national developments, may, by its example, induce this or another institution to make an effort to standardize good practice in some of the details that will be referred to.

It may be urged, why not specify what you think good in the ships in which you are concerned and let others put up with what they get? Laying aside many strong reasons and giving the selfish one, good details are much more cheaply obtained when they are general practice than when they have to be specially bargained for and perhaps specially designed for one's own ships.

Chain Cables

One point regarding these concerns the shipbuilder. Possibly the shipbuilder will insist that the point rather concerns the owner and his advisers, but as it is a point that becomes apparent on design of hawse pipe, the shipbuilder has first cognizance of it. This point is this—with most stockless anchors, in any but the smallest ships, the jointing shackle between anchor shackle and end link of cable is, with the anchors in "stowed" position, so far down in the pipe that it is impossible to knock out the shackle pin without lowering the anchor out of hawse pipe. If this unshackling were only required in dry dock, little harm would result, but as it is necessary, under certain conditions, to moor ships by the main cables, easy access to an end shackle is of importance. This is easily arranged for by the provision of a short length of cable, say four to eight feet long, according to need, on each anchor, thus bringing the shackle into an accessible position above deck, where, after the anchor has been "hung off," the shackle pin can easily be driven out.

The next point regarding cables is to some extent a reflection on the makers. Cable makers are supposed to work to some standard as to dimensions of cable links, end links and joining shackles; presumably, again, this is the Admiralty Cable Scale, of which the windlass makers issue useful tabular particulars. The form of certificate issued from the proving houses records the "length and breadth of link," but no report is made of variation among lengths of links, nor is any permissible "degree of tolerance" stated on the certificate.

Correct form of links, with consequent correct pitch of links, is of the greatest importance for reliable operation of the windlass. Cable lifters can, of course, be designed for any pitch of chain, but if the pitches are not reasonably equal throughout a ship's equipment, "jumping" of the cable over the "lifters" may ensue and undue wear and tear of the "whelps" will certainly occur.

Reference to this matter is not to be considered "finicky" or pedantic. A case came under the notice of the writer during the last three years where a large part of the cable equipment of a new steamer had to be replaced for this reason, and within the last few months he took an opportunity of checking over five lengths, all just delivered from one maker, and found the following variation in length overall of ten links when ranged by hand in dry dock bottom: No. 1 length 6 feet 9¼ inches, No. 2 length 6 feet 6¾ inches, No. 3 length 6 feet 8 inches, No. 4 length 6 feet 6 inches, No. 5 length 6 feet 9 inches.

Windlass makers probably do not expect perfection of pitching, and cable makers certainly cannot attain it, but some limits might well be agreed and test house officials might then be directed to check all lengths of cable when under light tension and record on certificate the correctness of end links and the maximum and minimum lengths over ten links, with power to reject cables not coming within agreed limits of variation.

Mooring and Warping Arrangements

The needs and requirements of our sailor friends deserve the fullest attention in this matter, and if their ideas appear to have expanded recently in connection with the fittings deemed requisite on even common tramps, we should remember that dimensions of such ships have continued to grow in most trades, and that at the same time lengths of jetties and berths have not necessarily been growing proportionately. Hence, methods of mooring and of handling warps that were possible under bygone conditions may no longer be applicable; for instance, hauling lines often now have to be run out from positions in the middle half-length of a steamer instead of over bow or stern as on shorter ships or at berths of great length. Further, at coal tips or other crowded berths ships are often scarfed or laid with their lengths partly overlapping, making safe and handy means of working breast ropes necessary.

It will be judged from this that all requirements are not fulfilled by quick-warping drums on windlass and a warping winch on the poop, useful and necessary as these helps are.

Fairlead sheaves on comparatively light cast iron stools are often fitted in neighborhood of windlass and of after winches. These are usually strong enough to act as guides or supports for warping wires between warping chocks and winch or windlass, provided the angle between the two directions of the wire is nearly 180 degrees, and these fairleads are useful in their own way, but what is really required in addition is the placing of strong warping guides on deck or on stools between winches and in other positions to deal with breast ropes. In some positions these ropes may have to be led with parts nearly or quite parallel, so applying to the fairlead a load equal to double the tension of the rope.

Fairleads and Bollards

These warping guides would not only save time in working the ship but would minimize the number of occasions when snatch blocks—easily strained and always destructive to the ship's wire—have to be used.

Fairleads are fitted at ship's side as well as the extra fairleads between winches. In too many cases horn fair-

leads only are fitted at side; these fairleads should be of ample strength, equal to the old horn fairleads.

It is also important that bitts or bollards should be so placed that the hauling line passes close to them between fairlead at ship's side and fairlead at winches, as this enables stoppers to be so used as to avoid loss of tautness of line while transferring from winch drum to bitts.

For all fairleads for warps there is a healthy tendency toward the use of sheaves of large diameter, and in most cases these sheaves are now provided with brass bushes.

The warping fairlead of old form is still common. In this type bushing of the roller or sheave is not sufficient; a brass washer should be provided at top and bottom also, otherwise the roller will almost invariably be found to be rusted up solid before the ship is many months old.

There are, however, several special forms of fairleads on the market and already widely used; their cost differs but little from the common form. As they are all self-lubricating and fitted with sheaves of large diameter and of good form, they are a distinct advantage to a ship in saving wear and tear of hauling lines. A point to be borne in mind, however, is that they give somewhat poor guidance to a wire led upwards steeply from ship to quay; some special arrangement may be necessary if much work of that kind is expected. These conditions rule in Panama Canal locks and have made necessary a form of mooring chock which will prove useful both under such conditions as to quays and where, as sometimes happens, a line has to be led from a loaded ship up to a light ship lying alongside.

Cargo Gear

One always feels that in a well organized world ships would not require to be fitted with a heavy and expensive outfit of cargo gear, to spend probably four-fifths of its time as ballast or as so much idle weight to be carried round at sea. However, while there remain ports where vessels may be asked to lie—as frequently at Hull, Rotterdam and elsewhere—with lighters at each side to receive cargo worked out by the ship's own winches, or ports in which, although quay berths are provided, enterprise does not "run to" cranes—ships other than those serving special trades must continue to carry about with them anything from four to thirty winches, with, in the latter case, a forest of masts, derricks and derrick posts to enable them to be utilized.

The elementary theory as to loads on derricks, spans, runners and blocks has been written about, calculated about and reduced to handy form in numerous textbooks—some even specially written for easy comprehension by the least mathematical of ship's officers. In spite of this, it is rare to find a sound view of cargo gear taken, even in the drawing office. In many yards cargo gear appears to have just grown by some system of trial and error, presided over by the foreman blacksmith. This man is, in most cases, a good man at his trade, but it does not follow that he is consequently an authority on determining dimensions or stresses.

The writer remembers the case of one yard where, repenting of these ways, the drawing office set to design derrick fittings, and a quite neat design was evolved. Unfortunately, the designer forgot that derricks are ever swung out over the side, and the span-head connections, while fairly satisfactory for the direct tension produced by a fore-and-aft position of derrick, were stressed to over 16 tons per square inch by the bending strain produced by the thwartship direction of spans when derricks were swung out. Probably the foreman blacksmith's eye, without calculation, would have been safer than this incomplete consideration.

Another example of the insufficient consideration given to cargo gear is evident in the choice usually made of cargo blocks for derrick ends.

Supposing a five-ton lift is required, the experts who order and the makers who supply the blocks usually consider they have behaved liberally by arranging for a block tested to seven and one-half or perhaps ten tons, and the unsuspecting sailorman and stevedore are expected to go happily and trustfully about their business of lifting a five-ton load. But what is the real margin here? First of all, considering deadload effects, the block under a seven and one-half-ton test is loaded. When supporting a five-ton load, in working positions, the method of application is quite different and results in pressures on pin and tension on suspending eye amounting to from about 1.8 times the load with derrick at 45 degrees to 1.95 times the load with derrick at 75 degrees. So the margin of test load over working load, instead of being 50 percent or 100 percent, has vanished, even if working load is a dead load.

The test load on the block, having been carefully applied by a testing machine, is certainly a dead load, producing stresses directly calculable by elementary methods. Working loads on cargo gear are, however, live loads—very much so. No matter how carefully they may be picked up, surgings and shocks are invariably produced in lowering and checking; by these the stresses are at least doubled as compared with those produced by the dead load arising from supporting the same weight at rest. This further discounts the utility of the test load, which in reality stresses the block much lower than working conditions will.

There is no doubt that we are often saved from breakages of cargo gear by the fact that the system yields when a load is checked or surges, or drops after a check. This yielding is mainly from the elastic stretching of the material of the span, runner and shrouds along with the deflection of mast or derrick post from unstrained position. The importance of this yielding, as a means of modifying the severe effects of impact, may be judged by the following comparison:

Assume a load of one ton drops from rest, with a free fall of one inch before the cargo gear begins to check its descent. At the moment when fall has been completely arrested the reaction of cargo gear is as follows, varying with the amount of give of the gear:

Yield of Point of Attachment of Load from First Check to Final Stoppage of Fall Inches	Reaction Stressing the Cargo Gear (1-Ton Load) Tons
1	4.00
2	3.00
3	2.66
4	2.50
6	2.33
12	2.16

It will thus be seen how difficult it is to get the stresses down even to double the stress arising from a dead load of the same weight.

Calculation of the expected yielding of the point of attachment would be somewhat tedious, especially as the bending of mast and stretch of shrouds are involved, but as a guide to the order of the dimensions involved it may be pointed out that the extension of 120 feet of steel wire rope, when stressed up to 6 tons per square inch, is probably between 5/8 inch and 1 inch. This 120 feet is mentioned as being the approximate total length of runner plus span, taking span as being carried down to cleats or bitts near deck. If a manila downhaul tackle is fitted the yield will be much greater and the multiplication of nominal stress somewhat decreased.

The old Admiralty "tests and loads for chain" quoted by Mackrow gives figures on the following basis:

1-inch chain—breaking strain, 27 tons;
proof strain, 12 tons,

and states that the working strain for crane chains, etc., should not exceed two-ninths the breaking strain or half the proof strain.

It is to be noted that the stress on material, taken on sides of chain links, would thus be:

At breaking load.	17.2 tons per square inch
At proof load....	7.63 tons per square inch = 17,100 lbs. per square inch
At working load..	3.81 tons per square inch = 8,550 lbs. per square inch

The working load stress may appear high, but it must be remembered that a chain load is never reversed.

Presumably this refers to the best class of wrought iron, of which the breaking stress of the unworked material would be sensibly higher than the breaking stress of the chain on test. Even making allowances for such steel as is now used in blocks and other cargo gear forgings or stampings, in place of iron as in chain, it would not appear advisable to exceed these calculated stresses (that is, calculated as if dead loads), particularly in view of the somewhat indeterminate live load effects already referred to. This much we can definitely say, that where we design for a nominal stress under dead load of about 3.8 tons per square inch, the live load effect will raise the actual stress at least up to the proof stress of 7.6 tons per square inch, and, while the margin between the latter stress and the breaking stress of mild steel in either forgings or stampings is none too great, still less is the margin between the proof stress and the elastic limit excessive.

It should never be forgotten that the factor of safety, where live loads are concerned, is not more than half its nominal dead load value.

Textbook and Common Sense

Now all this cargo gear criticism is merely a mixture of elementary textbook and common sense—or what the writer hopes is common sense—but unfortunately he finds that the textbook and the common sense points of view are not always applied to cargo blocks. The shipbuilder usually orders from manufacturers an outfit of ready-made blocks, tested to five tons or seven and one-half tons, or whatever occurs to him as a reasonable margin over the owner's desired lifts. Manufacturers are not infallible, either. In the case of one much patronized maker of blocks a request for drawings for inspection brought the reply, "Sorry, we have no drawings. Our work is all done to templates." In such a case there is always a fear that there never have been any drawings, or that ancient error has been copied from another manufacturer. Some alleged specialties are admittedly "designed" by copying those of other makers, mistakes included, without any questioning criticism on the part of the copyist.

The writer has examined stresses of a cargo block, dimensioned and found stresses per ton of load at eye (or what is the same, per ton load on pin) as follows:

Part	Nature of Stress	Per Square Inch Stress per Ton Load at Eye
Pin	Shearing	.338 ton or 724 pounds
Pin	Bending $\frac{WL}{8}$ taken	.918 ton or 2,060 pounds
Pin	Pressure on bearing	869 pounds
Binding	Tension at pinhole	.491 ton or 1,100 pounds
Oval eye	Tension on sides	.4075 tons or 915 pounds
Neck of eye......	Tension	No data

The maker's test load for this block is not known; the working load suggested is five tons, and, after making allowances for method of application of working load, the apparent stresses (leaving live load and shock out of account) are as follows:

Stress No.	Stress or Load per Square Inch Under Proposed Working Load
1...........................	3.29 tons or 7,050 pounds
2...........................	8.94 tons or 20,000 pounds
3...........................	8,450 pounds
4...........................	4.78 tons or 10,700 pounds
5...........................	3.97 tons or 8,910 pounds
6...........................	No data

A double sheave block proposed by makers for a test load of twenty tons showed, when investigated, stresses under test load as below. Stresses under working load are also tabulated assuming working load half the test load and that, as is possible, the block is used combined either with a single or a double sheaved block, the fall rope adding in the one case one-third, and the other one-fourth to the load on pin and on eye.

Part	Nature of Stress	Stresses — Tons per Square Inch: Under Test (20 Tons)	Under Working Loads: With Single Block	With Double Block
Pin	Shearing	4.81	2.77	2.6
Pin	Bending	2.57	1.70	1.6
Pin	Pressure on bearing	2.86	1.90	1.79
Binding	Tension at pinhole	8.90	5.94	5.55
Oval eye.......	Tension in sides	10.00	6.70	6.25
Neck of eye...	Tension	13.4	9.00	8.43

It will be noticed that in a double block, whether coupled with another double block or with a single block, the effect of the fall rope in reducing the margin between real effect of working load and the test load is much less than in the case of a single sheave block already commented on.

The writer submits that even allowing for the fact that the loading of the blocks, like that of chains, is never reversed, some of the stresses tabulated are very much too high, both on test and on working loads, and especially with the working loads when in addition live load effects are kept in view.

One might examine the whole range of details of cargo gear and find much to criticise; probably in many cases stresses even above those tabulated could be discovered.

It may be asked, "How are there so few accidents with cargo gear?" One help is that even where, say, five-ton gear is specified, a ship may make many successive voyages with only two and one-half or three-ton lifts to make, and when a five-ton lift is made a distrustful chief officer will often take special precautions, such as using purchase blocks and preventers. It will be admitted that if gear is installed as five-ton gear, these precautions should not be necessary; a little care would ensure this at comparatively small expense if good practice were, by a standard specification or otherwise, made common. Most of us know of accidents under present conditions of design.

Meanwhile, may the writer suggest that a reasonable basis for stresses in cargo gear forgings of steel would specify that where loads in a single direction only are to be applied, stresses should not exceed a nominal 8,000 pounds per square inch under working loads, that where reversal of stress occurs 5,000 pounds per square inch should not be exceeded, and that both these figures should be reduced where sectional area of any parts is less than one square inch or a part is less than five-eighths inch thick.

These stresses would allow some margin for live load effects, but parts subject to wear should be dimensioned in excess.

From this short consideration of stresses on cargo gear the writer would like to pass to consider for a few minutes some points in cargo gear arrangements.

Many ship general arrangements, when examined, show a fore stay and a back stay to each lower mast, and it will generally be found that these stays have been taken into

consideration in the staying of the mast against cargo loads

In view of the fact that derricks, even where fitted in pairs, must swing across the center, those stays have to be "let go" during working of cargo, unless work is never to be carried on simultaneously at two adjacent hatchways. These stays are useful to prevent undue vibration of the mast at sea, but they should never be counted on for cargo discharging purchases; the necessary support to the mast should be obtained by spreading out the lower ends of shrouds sufficiently and, where ten to twenty-ton lifts have to be provided for, by fitting additional shrouds for temporary use on the opposite side of the mast to the heavy lifting gear with their lower ends still further spread out. These will not seriously hamper discharging from adjacent hatchways, especially as during extra heavy lift work in adjacent hatches will generally be suspended.

A point about heavy lifting gear sometimes neglected is that the step for the heavy derrick should be placed as close to the mast as possible, so that it may be, as directly as possible, under the point of suspension of the span at lower mast head, otherwise the guying of the heavy derrick requires heavy tackle.

Details of all this gear require careful consideration. Some of the commonly used arrangements of long links and shackles for span heads are not satisfactory, stresses being excessive in certain positions of the derrick.

Another important point with regard to cargo gear is the means for handling derrick spans. In some cases a purchase block is fitted above derrick with a guide block on cross tree of mast, forming a purchase tackle, the fall end of the same wire being led to belaying cleats or bitts about the base of mast.

To raise or lower the derrick with this arrangement is rather a dangerous operation, as the wire has to be stoppered and the end taken to winch barrel or warping drum, and when the derrick has been lifted to somewhere above the desired position it has to be again stoppered, while the wire end is again made fast to cleats or bitts.

To avoid the danger and inconvenience of these operations, a topping lift should be fitted to each derrick, the simplest arrangement consisting of a single part span passing over guide block at cross trees of mast with a downhauling tackle either of light wire or of manila connected to an eye in the span end, which is at cross trees when the derrick is down. With this arrangement the derrick can be lifted or lowered to any desired position and the working span fall then made fast to bitts or bollards.

The writer feels that in touching on cargo gear he has taken a bigger subject than can be reasonably dealt with as part of a general paper. There is undoubtedly room for an examination of the whole subject, and plenty of material for a long and important contribution to the proceedings of the institution.

Erections

It will be remembered by many of the members that there was a time when so-called erections on a ship were practically neglected in strength calculations. It seemed to be taken for granted that because they were lightly constructed they did not take part in the straining of the ship.

While shipbuilders and others neglected this, natural laws did not, with the result that these erections were subjected to stresses roughly proportional to their distance from the neutral axis of the vessel, although possibly they did not add very much to the strengh, in view of their lightness.

The results showed themselves in various ways—upper decks tearing, houses working, and in some cases weakness showing on a strong deck at the abrupt end of a house which stiffened it locally.

In the main parts of the structure of a ship these bad effects are now prevented by suitable means, but there are some minor ways in which the operation of the laws of elasticity show themselves. The writer has in mind a case which he saw recently, where a bulwark plate was fitted abreast deck houses on a shelter deck ship. The ends of the bulwark plates were shaped for sightliness and there was no great indication of strain there. The upper edge of the plate, however, at about its mid-length had been stepped, so that a wood rail abreast the house might run with its top at the same level as the bulb angle stiffener fitted on the remainder of the length of the top edge of plate. There was thus an abrupt stoppage of the light bulb angle, in addition to the square cut in the plate edge; the consequent concentration of stresses in this corner fractured the bulwark plate.

It is also found that detached houses well above a shelter deck may acutely feel the straining of a ship in bad weather to the extent that the seams of their wooden top decks will cease to be watertight. These often take up again when bad weather and consequent straining and working of the ship cease. It seems evident that better arrangements on these house tops are necessary; possibly the addition of tie plates would be beneficial.

Another position in which house tops do not receive sufficient care in design occurs alongside the engine casings. It is common here to attach beam ends to the engine casing side by simple lugs, or even by a strap piece bent at right angles, with a couple of rivets each way, the rivets through the casing side sometimes being so far from the beam that the connection lacks stiffness. A wood deck on such supports certainly does not get fair play, and would give much more satisfaction if a tie plate with angle to casing side were fitted fore and aft on top of the beams before laying any wood. The beams, too, would probably be better if somewhat stiffer than usual in such positions, and if fitted with small knee brackets. The writer's views on this matter are strengthened by his knowledge of the case of a ship in which such a deck is quite satisfactory on one side of the ship and is very unsatisfactory on the other side; on the satisfactory side a steel bulkhead parallel to the casing forms an intermediate support for the beams, while the beams on the other side of the ship have no such support, there being on that side only a wood bulkhead. This plainly points to lack of stiffness of the beams as one of the principal causes of this deck leaking. There is, of course, not much weight on the deck above, but the beams and their connection evidently take part in the general working of the ship.

Windlasses and Hand Steering Gear

Better provision might well be made for means of closing the chain pipes through the windlass bedplate when a vessel gets away into deep water. If the windlass makers could give us a little higher lip on the chain pipes on the top of the bedplate to enable a canvas coat to be lashed to it and also to the cable, there would be more security against getting unnecessary water down into the chain lockers when the steamer digs her nose into a head sea.

At the present time makeshift methods of covering up the closing plate usually supplied for the top of these chain pipes with Portland cement are sometimes adopted. These methods would be more effective if the plate was so cut as to make a more complete closing and to drop a little way into the chain pipe and rest there on an internal lip.

Most cargo ships with steering engine amidships are still fitted with a hand steering gear aft. This is in practically all cases so slow and clumsy as to be almost useless. In some cases reported to the writer where, through breaking of steering chains, the hand gear aft has had to be put into operation, a smashup of the gear has been the result. Possibly straining during coupling up with the rudder lashing about may have had something to do with the trouble. At the same time the writer was never very strongly impressed by the amount or disposition of material in these gears; the nuts always appear so very weak in proportion to the large screws employed.

Some builders have, in recent examples, abolished these hand gears in favor of an arrangement for steering by means of the after winches, and with a good arrangement this would appear to the writer likely to produce better control of the ship than could be maintained by even a large number of men at the hand wheel, which must really be too slow for effective control, whether the ship is under her own steam or broken down and in tow.

Probably an efficient arrangement of this kind would obtain sanction as an alternative method of steering from the registration societies. This system seems worth working out.

Steam and Exhaust Pipes

Very objectionable methods of carrying steam and exhaust pipes through casing sides, decks and casing tops are still sometimes employed. The worst of these methods is the sandwich joint. A less objectionable method is sometimes employed, but in view of the fact that leakage from this will generally blow onto the plating, this is not much better than the sandwich joint.

This should be employed wherever space permits. The arrangement permits the use of bolts instead of studs and keeps the joints at such a distance from the plating that if a leak has to go uncorrected for some time the plating, at any rate, does not suffer, while the fact that heat is not so readily conducted from the pipe and its contents to the plating also helps to keep down corrosion.

Stoves Pipes

Lack of thought is often shown in the fittings employed for carrying stove pipes through wood decks or wood sheathing. If you inquire regarding this matter in the drawing office or in the yard manager's room, you generally receive a most confident assurance that an excellent system is employed, and possibly a very good sketch may be submitted. If, however, you follow the matter up in the yard you often find that a most rudimentary fitting, consisting of an iron coaming pipe with a narrow iron flange ring, is being fitted by the carpenter. If he is a thoughtful tradesman, and if the flange on the coaming pipe provided by the store happens to be large enough to permit it, he will possibly cut the wood of the deck or the sheathing one-half inch larger than the pipe each side, and if he happens to think of the matter he may put a strip or two of asbestos millboard in the space thus formed. The chances are, however, that if this is a wood deck, there is nothing to prevent the asbestos from dropping through, and the chances are still greater that if the stove pipe passes through a space in which there is a wood ceiling and beam casings below the wooden deck, the spigot will not be long enough to come well through both the deck and the ceiling, so that there is nothing but the thin and easily corroded stove pipe between the hot gases and the space at the back of the ceiling. A really good system requires to be worked out and made universal for stove pipe coamings.

Perhaps no item among the smaller details of ship's equipment causes more trouble during the lifetime of a ship than port lights or scuttles. As a mechanical contrivance the ordinary side scuttle leaves much to be desired. Tightening is effected by a single screw, the balancing reaction at the opposite side of the glass frame being the dead inadjustable support of a hinge bolt. Hence, if the rubber packing is hard and rather thick, the means taken by Jack to cure the leak that is soaking his surroundings with sea water—putting the poker end or a spanner into the loop of the nut and heaving up tight—is likely to result in a serious straining of the glass frame. Another frequent cause of strain is the effect of a gradual filling up by successive paintings of the slight clearance between spigot part of glass frame and inner diameter of the cast iron or main frame. Here Jack never dreams of the cause of the trouble and heaves her up tight—tight enough, but not watertight.

Small Fittings

No care in design will ever make a sidelight absolutely fool proof. They would certainly be more satisfactory if a hinged screw were fitted upon the hinge pin, with sufficient play in the hinge eyes to permit the screw to apply some pressure. The writer thinks this system was at one time on the market, but did not take. A double jointed hinge would be rather better, with a similar screw, as it would not depend upon any play in the hinge eyes.

To withstand blows of seas and pressure from fenders, sidelight frames applied by some builders to forecastle and poop sides should be much stronger, particularly when, as usual in cargo boat practice, cast iron flanges are used.

Any guidance specification, in referring to this matter, might well stipulate a minimum weight of brass for the glass frame and of cast iron for the main flange, as well as giving sections of these parts and thickness of glass.

At normal times the handling of sidelights is a very much cut trade. Orders move from firm to firm on very small margins of price, and the poor policy of cutting down materials to about the minimum that will hang together is followed by some manufacturers, and even by some builders who make their own sidelights.

Summary

A paper of this length cannot by any means exhaust the list of matter requiring greater attention in ship design and construction.

Possibly much that is taken for granted and carried out without question under present practice would not stand criticism if looked into. Take, for instance, a hatch coaming with heavy flange on lower edge. Considered as a girder, its section is appallingly inefficient, its neutral axis is most unsuitably placed, and the edge which has to stand compressional stress is of the poorest form for the purpose, the hollow, half-round molding being useless except to prevent chafing of the tarpaulin, its rivets are not even in shear to enable it to help the plate efficiently.

Recently builders and the registration societies after a royal commission woke up and have applied bulb angle stiffeners to coamings in certain cases, in a position that helps against the compressive stress, both by raising the neutral axis and by adding lateral stiffness to the plate.

Possibly there are other details where equally radical treatment would be justified, and this paper will not have been useless if it leads other members to draw attention to and, if possible, to indicate the necessary corrections for such errors in practice.

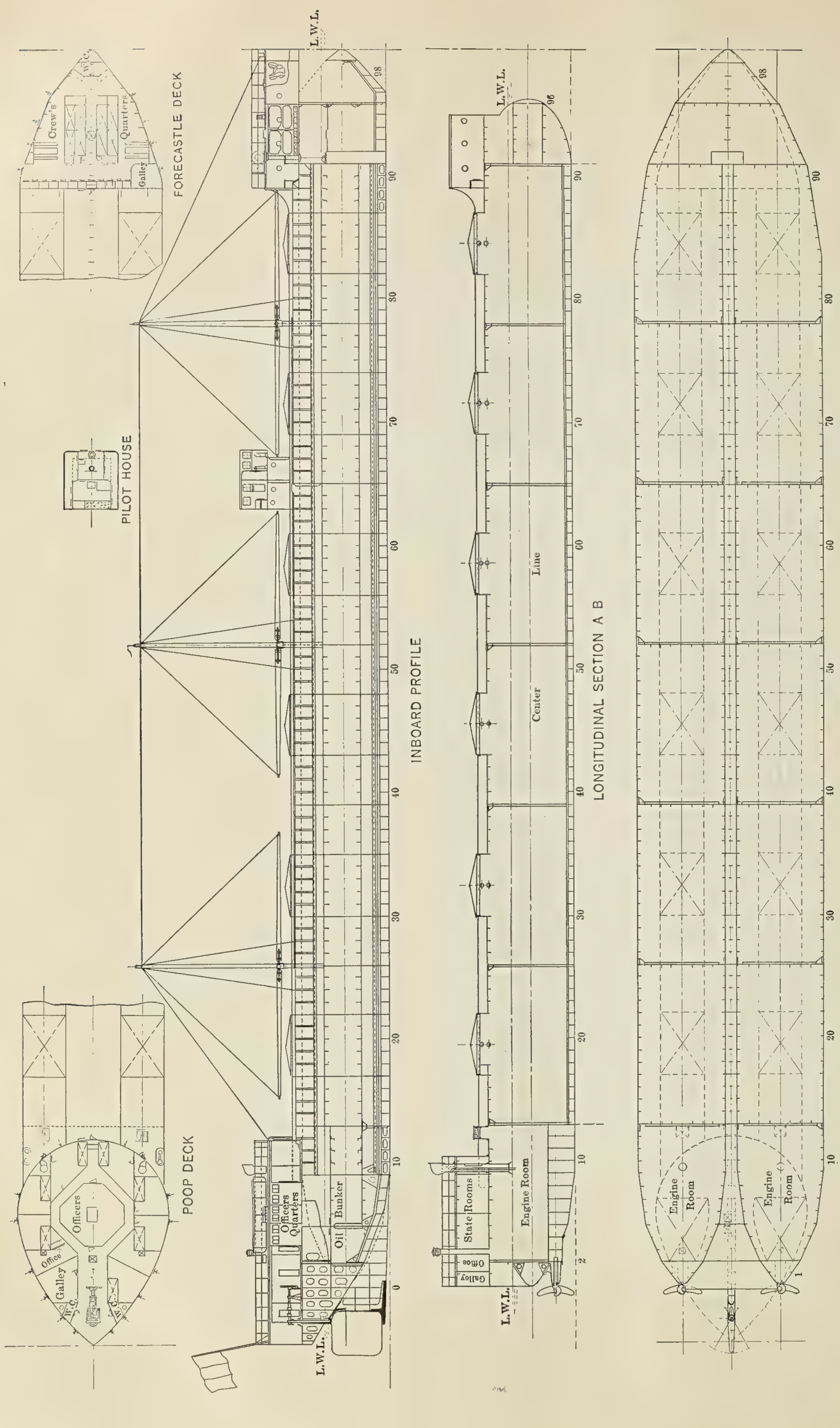


Fig. 1.—General Arrangement of French Unsinkable Ship

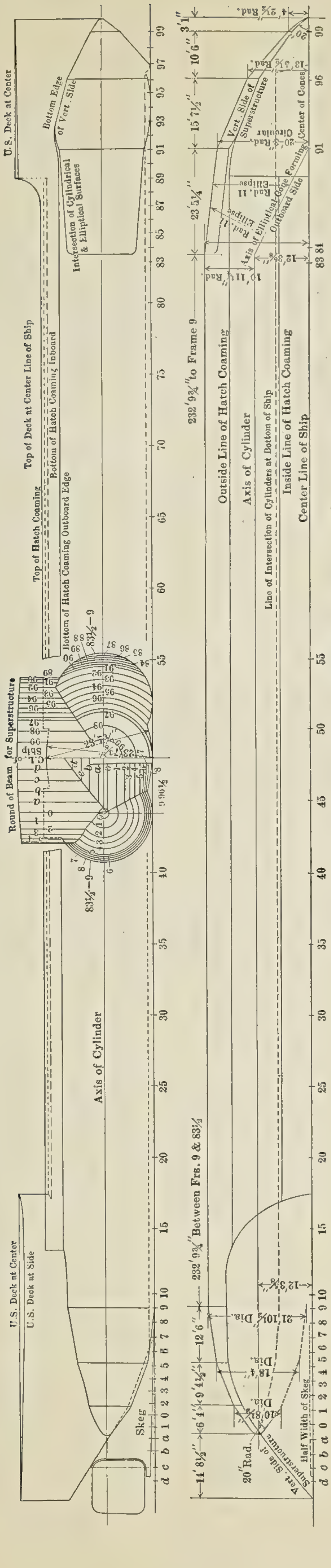


Fig. 2.—Molded Lines of French Unsinkable Ship

Unsinkable Freight Ship of French Design

The problem of constructing a so-called unsinkable ship has been met with in a design which has been subjected to expert naval discussion and approved to an extent that the Foundation Company, New York, has received a contract from the French government for the construction and equipment of five steel cargo steamers of this type. Work on these craft has already begun.

M. La Parmentier, French naval engineer, is responsible for the design, after numerous practical experiments and theoretical study of the stability of floating bodies. Therefore, the term "unsinkable" can be applied to this design in more than a figurative sense, and in undertaking the development of such a design M. La Parmentier was led to adopt the following fundamental principles:

1. That the vessel must be divided into a number of watertight compartments.

2. That the details of the framing should not involve impractical and costly construction.

Conditions Fulfilled in Design

Both of these principles will be fulfilled, it is claimed, by the ships now under construction at one of the Foundation Company's Southern yards. As indicated by the midship section, the vessel consists of two parallel cylindrical hulls joined by transverse bulkheads. The cylindrical shape gives the maximum of hull strength and provides inner walls to withstand the tremendous force of a torpedo explosion.

Furthermore, these walls form two longitudinal watertight bulkheads, strengthened by watertight transverse members, which join the two cylinders and form six centrally located reserve buoyancy compartments. Each cylinder is itself subdivided by watertight compartments.

The experiments made by the French government indicate that not more than two compartments in one cylindrical hull, and possibly two, in the adjoining reserve buoyancy space, would be penetrated by the explosion of a torpedo at the side of the vessel. Assuming that only two compartments in the outside cylindrical portion of the hull were flooded, the ship would list about four degrees. The effects upon the trim of the vessel of flooding first four and then six compartments of one hull would not therefore be serious.

Buoyancy of Ship Maintained

It is said the calculations show that even though one hull were completely flooded, the buoyancy of the opposite hull and the adjoining reserve space would keep the vessel afloat. And even in this condition the ship could be brought into port by the propelling machinery in the undamaged hull, this unit being entirely independent of the engines and boilers installed in the submerged hull.

The La Parmentier designs call for a ship 320 feet long, with cylinders 20 feet in diameter, which will have a deadweight capacity of 4,250 tons on 16 feet draft. Twin-screw steam engines of 700 horsepower each will be installed, and they are expected to give a speed of eight knots when the ship is loaded. Three cargo masts with six cargo booms will be provided, the masts being stepped between the two cylinders, with winches in the fore-and-aft passageway.

An unsinkable ship of practical design would revolutionize the shipping industry, as well as call for a big readjustment of insurance rates at Lloyds. The designs shown herewith may prove a genuine step forward toward the realization of this aim. That it appears at least prac-

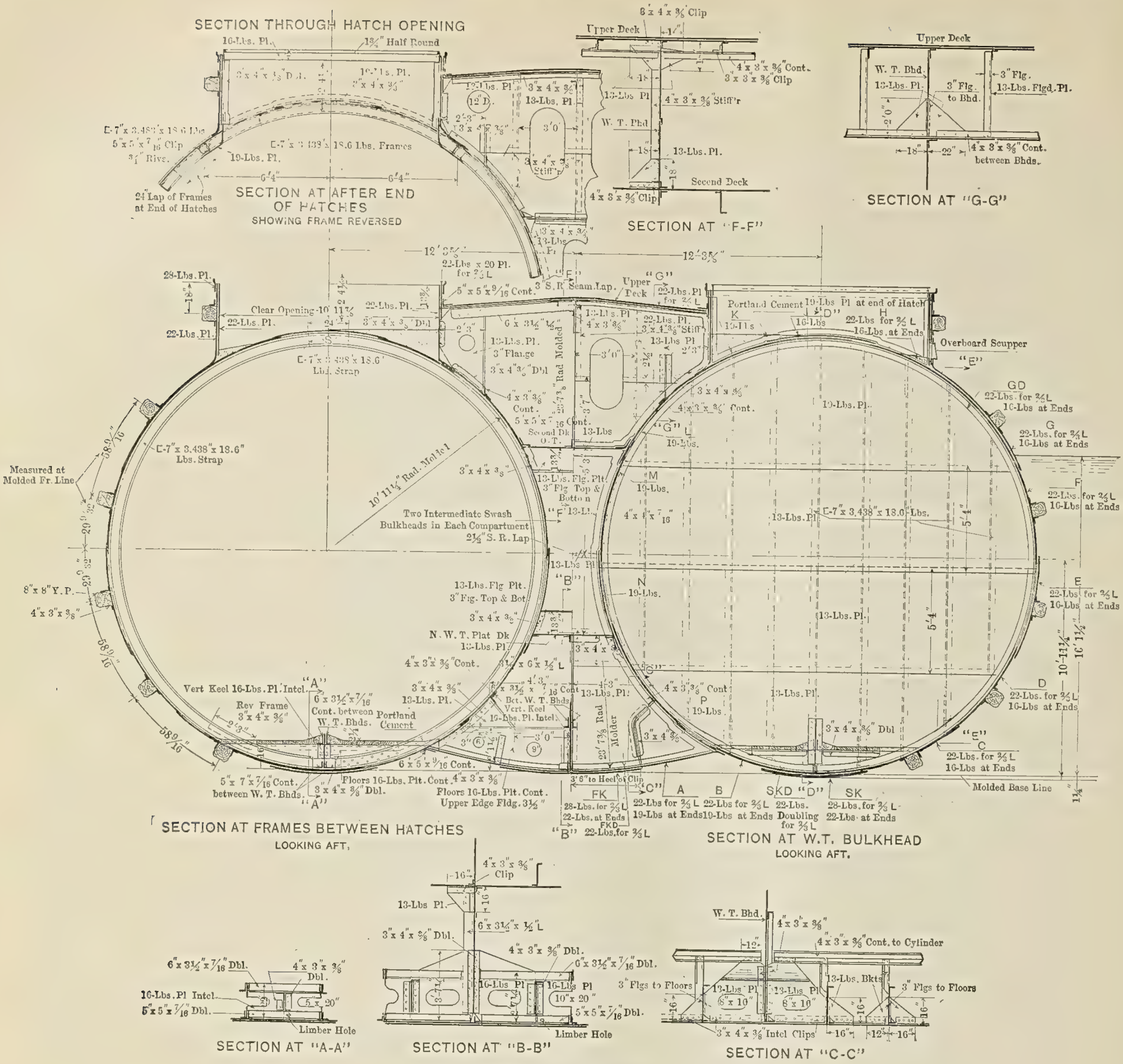


Fig. 3.—Midship Section

ticable is evident in that the French naval experts have accorded it a considerable measure of enthusiasm. The results should be followed with interest by the whole shipbuilding world.

Pneumatic Riveting and Rivet Shortage

With regard to the reduced rate of output in merchant shipping, one of the chief causes is the shortage of riveters, a condition which, it is urged, could be overcome by the wide use of pneumatic riveting.

According to information recently received from one of the leading East coast shipyards, the best day's work on a shell with pneumatic riveting is 700 rivets of seven-eighths of an inch diameter, and for hand work, under the same conditions, 430. An average day's work, however, is considerably less than this, and may be taken as being 510 rivets with pneumatic riveters against 264 with a hand squad, the figures being taken for work on all parts of one ship.

The greatly increased output of work secured by the pneumatic tool is in itself sufficient to establish its enormous superiority over the hand method. But it has another very important advantage in that the pneumatic tool requires fewer men to work it. A hand riveting squad consists of three men and one or two boys, and from two of these squads three pneumatic riveting squads can be formed, effecting a saving of fifty percent in labor alone. A third advantage of the pneumatic tool is that it gives both the other great advantages with less exertion, and consequently less fatigue on the part of the men. The United States yards, by their almost universal employment of pneumatic riveting tools, have been able to overcome their shortage of skilled labor.

Chairman Hurley, of the Shipping Board, and Charles M. Schwab, Director General of the Emergency Fleet Corporation, have appealed to Marshal General Crowder for deferred classification for most of the vast army of shipworkers who registered under the new draft. They argue that these men are essential to the success of the shipbuilding programme, and that shipbuilding is ranked first in its importance to the prosecution of the war.

The Heavy Oil Engine*

Discussion of Factors To Be Considered in Design—Small Demand as Yet for Heavy Oil Types—Future Possibilities

BY CHARLES E. LUCKE†

THE heavy oil engine is of particular interest these days because those who are familiar with the problem believe a change is coming in the situation. It is my intention to present, in a more or less informal way, some of the ideas involved in the development up to the present time and also those which lead us to believe that a change is about to take place, and in about what direction. What I say is somewhat in the nature of a prediction, although he is a bold man who undertakes to make a prediction on these matters. Nevertheless, I am inclined to have a little more confidence than usual, because about a year ago I talked to you here about aeronautical engines and showed those who were not already familiar with that fact from what a chaotic state the art of aeronautical engine construction was then emerging, and ventured to lay down some general lines of practice that seemed to be proper and a good basis for future work to follow.

Since that time this country has been drawn into the great war, and, likewise, since then the Liberty motor has been designed and put on a manufacturing basis. A good many ideas that were presented a year ago before the inception of that motor, and before there were standards of any kind, have been incorporated in it. A number of the things which were then not standard and which were recommended as standard have since become standard.

I feel, therefore, somewhat more confident in the sort of prediction to be made to-night on the heavy oil engine.

Internal Combustion Engine for Navy

It may be of interest for me also to say here that, as a result of the war, my entire time, to the exclusion of all other things, has been devoted to the subject of internal combustion engines for the navy service. The Navy Department has established at Columbia—about the Mechanical Engineering Department, as a nucleus—the official United States Navy Gas Engine School, and over 900 men have been given, all without any internal combustion experience before they came, a four-weeks' finishing course of training and have been turned out into the service. Of those men, the leading engineers of over 200 of the submarine chasers form a part. That work is now going on and will continue until all these boats have been manned with trained men.

It is interesting to note, also, that these boats were non-existent a year ago; they did not even exist completely on paper, and before a year will have passed from the time when they were paper things there will have been completed, and in the water and completely manned and officered by trained men, over 300 of them. Even though that is a small matter in the naval programme, it is nevertheless an accomplishment that all ought to feel proud of.

The gas engine school at Columbia University is also now undertaking to train the engineers and leading mechanics to take charge of the motors for the navy foreign flying base station service. I mention that because I want something from you in that connection; to help secure fine, competent internal combustion engine men who are also machinists, and therefore the kind of men that can safely be trusted with the enormous responsibility of proper maintenance of an aeronautical motor, the failure of which may cause the sacrifice of life. We will not undertake to train any man who is not at the start a pretty good man—at least from the experience standpoint. We are not finding these men at the present time as fast as we need them, so I am mentioning this fact with the idea that those of you who are here and who know such men will let me have their names, or at least tell them to apply for that class of service, if they like it, and I will see what can be done to bring them in. The leading men will receive the rank of ensign in Class 5, the Naval Reserve Flying Corps, and will have the job of engineer officer.

Possibilities of Heavy Oil Engine

To return to the subject, the heavy oil engine. The heavy oil engine in this country has never amounted to very much. That fact itself should prompt some inquiry, because this country is the home of petroleum.

The heavy oil engine as an internal combustion engine has so far proved itself to be capable of the highest known thermal efficiency in transforming the heat of combustion into work. Efficiencies approaching 40 percent are normal, and in some rare cases this is exceeded. This is not equaled by any other system that has ever been produced.

Putting those two facts side by side, you will see a cause for wonder at once. Here is America producing more petroleum than any other country in the world, and doing it for a long time back—something like fifty years—and yet the motor that operates with this oil—the most efficient known—the heavy oil engine in this land of petroleum is, compared with other classes of machinery, practically a failure. It is a failure in the sense that the business of producing it has not expanded materially, and it has been in general an unprofitable business. No one in this country has made much, if any, money in building oil engines, and a great many who have thought of going into the business with excellent prospects, good plans and plenty of capital behind them finally decided not to do so on the record of failure to produce dividends on the part of those who are already in.

The Commercial Demand Small

There has been from the beginning great interest in the oil engine. It is a thing attractive to the mind. Everybody thinks about it. And yet, on the commercial side, there has been very little demand—not sufficient demand anywhere to warrant any really large establishment confining itself to the production of oil engines with a competent engineering staff and research department such as would be necessary to do the thing right. This lack of demand is rather difficult to explain, but it is nevertheless real. Assume it to be a fact, without investigation, and put it down as the first of the various causes for lack of development. The next cause is the fact that this is the land of petroleum, and therefore the land where petroleum and its products are held in least value. In other words, we are prodigal of petroleum and have not the induce-

* Paper read before the Engineers' Club of Philadelphia, January 29, 1918.

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ment, by reason of our multiple supply, to economize it. In the place where oil is so plentiful, naturally it is not regarded as a valuable product—not nearly so much as in a distant country, where its cost is high. That fact makes the high efficiency mentioned before lose its attractions, and when it is remembered that the machine to produce this high efficiency is a costly machine, therein lie the elements of financial balance that turns the wrong way.

The cost of power, when it is the controlling factor—and that is usually the case in stationary installations—is made up of two charges: fixed and operating. The fixed charges are based primarily on the first cost of the engine, and the heavy oil engine has always been an expensive engine—never less than 60 dollars per horsepower, and often as much as 80 dollars per horsepower. On the other side is the operating expense, the principal item of which usually is the cost of fuel. The more highly efficient is the engine, in fuel consumption, the less will be the fuel cost per horsepower hour, and therefore the more prominently this heavy fixed charge will stand out.

In all cases where the cost of power is the controlling factor these financial facts are to be laid beside the fact of the lack of demand for these oil engines. Nevertheless, as time goes on, inventors, designers and research men are not deterred from trying out schemes, so that, in spite of this lack of financial and business encouragement, there is a very considerable degree of progress—much slower than it ought to be, but nevertheless real. Unfortunately, in this case the public in general is not informed about this progress, and therefore when, due to a change in economic conditions, the time comes to make use of all the available information on the subject, we suddenly wake up to the fact that it is in the hands of a few people, and the rest of the public knows nothing about it.

Time for Activity

The present is a time of change, and there are two reasons for that. In the first place, the war has brought about a shipping situation which is unprecedented in the history of the world. There is a demand for ships to-day such as never existed before, but there is at the same time just as real and as strong a demand for the men to run those ships. The heavy oil engine is one of the various possible ways of driving a ship, providing the ship be not too large. Its fuel economy is a direct value in ship operation, since it gives a larger cruising radius or the maximum possible cargo capacity. It furthermore is peculiarly adapted to a ship, in view of the fact that we are facing a labor shortage in ship operation, and the heavy oil engine ship can be operated with less men below deck than any other type of vessel ever produced—except, of course, the small gasoline boat. The war, then, has brought to our attention this heavy oil engine as a possible motive power for the smaller of these new merchant vessels as well as naval vessels, though more merchant than naval. And it is a fact that shipping people are considering this question to-day all over the country, but most of them are afraid to act. They would like to, as near as I can find out by talking to them, but they are afraid to act. To my mind the time is not far distant when they will have to act, or lose something by not acting.

Aside from the shipping situation, there is another reason, and that is the economic reason of an appreciation of the value of this wonderful fuel that Nature has placed beneath our country's land surface. This fuel is peculiarly adapted to this sort of use: the generation of power in internal combustion engines directly, with the highest possible efficiency and the least possible man attendance. Fuel has been wasted in this country, especially in that region near the oil fields, just because it was plentiful. Nevertheless, we are coming to the point when the people—if not the people, certainly the Government—will be compelled to force the abandonment of the use of this fuel for all purposes where other kinds of fuel that can be had in more plentiful supplies would do as well. When you consider that oil or petroleum is the only kind of fuel that can be used in the high efficiency engine, then it becomes clear that to burn it to warm a living room where charcoal or wood or coal of any grade would do quite as well is to commit a sort of economic crime. That feeling and the financial consequences of not acting upon the realization of that situation will come to a climax before very long and result in a plan for conservation of our liquid fuel or petroleum supply, so that it shall be used for only those purposes for which it is peculiarly adapted and be barred from all other uses where other things will suffice. In the natural course of events people wait for prices to bring such a situation about, but this is not a time that properly is classifiable as belonging in the natural course of events. This is a time which is distinctly abnormal and unnatural. We hear every day plans proposed and turned down because there is no precedent, with always the rejoinder that here we are in a great war for which there is no precedent, so why follow precedents in other things? We have been forced to change in a thousand and one things, so let us change in a thousand and two things, and do it quickly.

I could expand to considerable length along the lines of the economic situation with regard to the use of oil and the peculiar adaptability of oil in the internal combustion engine, and the particular adaptability of that class of engine to the ship service, but I want you to realize that there is another field also where there is a demand slowly but surely growing up, and that all these separate demands, coupled with the growing change in the economic situation, must certainly, one piling on top of the other, produce a new condition which I foresee.

Difficulties in Automobile Industry

We have a real gasoline (petrol) automobile industry, and it is becoming a great manufacturing industry, but it is to-day tied up to and inherently dependent upon the lighter petroleum distillates. There is no highly economical gasoline (petrol) or kerosene (paraffin) engine, and every reason leads us to believe fundamentally that none can be produced on the present system. To make our automobiles and motor trucks and tractors run, and to make our available sources of fuel supply last, there seems to be only one solution, and the leading engineers and mechanics in the automobile industry are beginning to talk about that solution: the adaptation of the heavy oil type of engine to the high speed class of service which such as the automobile and the tractor require. It is coming; there can be no question about it. If anybody is able to-day to produce the high speed type of engine necessary, even though it costs more money to build, rest assured it will be adopted very quickly.

There is a third field, and that is the field of direct-connected electric generating sets. For a long time in the gas engine business we built engines to drive generators in a kind of haphazard fashion. As time went on a particular type of outfit began to appear—a direct-connected, high-speed generating set, with engine and generator on one base, self-contained, the best example of which, on a small scale, is the Delco lighting outfit, which is being sold at the rate of over 50,000 sets a year now all over the country districts. There are corresponding units of other designs

in larger sizes. The fact that these sets are generally confined to gasoline (petrol) limits their use, because in many places gasoline (petrol) is unsafe to use; in other places it is not obtainable; in still others the cost of it is prohibitive. It is apparent that if we had the heavy oil engine adapted to that class of high-speed, multi-cylinder service, and with the necessary degree of regulation, it would open up still another field.

So in the field of application of the heavy oil engine I see just ready to be invaded these three things: First, a widened use for ships; second, a new use in the automobile type of motor; third, a corresponding new use for direct-connected, high-speed electric generating sets. Whether they be used on land or aboard ship, it does not matter. If they are designed right they are serviceable in either place.

It is of interest, and particularly pertinent here, to review some of the ideas that have been developed to date, and some of the suggestions available as lines of possible development in the direction of real progress. And this review I divide, for the purpose of clarification, into two topics—functional and structural.

Functional Discussion

Under the functional come all those questions connected with the supply of air, the supply of oil, the establishment of the proper relations between the oil and air to give the desired control of combustion after the necessary compression—in fact, all those physical processes involved directly in the development of the power within the cylinder.

Under the head of structural would come all those principles of type arrangements or typical part forms, and proper proportions of the metal structure that houses these physical processes and there produces a machine.

The first item under the functional discussion is that of charging the cylinder with air, and this is carried out by either the so-called and well-understood 4-cycle system of two valves per cylinder, or by any one of several 2-cycle schemes. Of the 2-cycle schemes there are a number. First we have the ordinary crank case precompression chamber, which is barred from any engine of more than diminutive size, because the closing of the crank case prevents access to the working parts, in addition to imposing other bad conditions. The first step in avoiding the difficulties of the closed crank case, which are prohibitive in any real engine, comes when the connecting rod and crank shaft are left open and the front end of the cylinder closed, the front end acting as a precompression or air-charging chamber in conjunction with an air reservoir, which is necessary, so that the pressure in the front end of the cylinder cannot rise too high.

Faults of Front End Compression

This front end compression arrangement has certain faults that have led to the design and more wide use of others. For example, it is not possible in the oil engine of the 2-cycle sort, with the front end precompression chamber, to put into the motor end a volume of air equal to the piston displacement; the volume must necessarily be less than the piston displacement measured at atmospheric pressure. That being the case, some of the burned gases or products of combustion cannot be expelled, and, at the same time, the residue is hotter than it otherwise would be. To correct that, the alternative schemes of a step piston or a separate scavenging pump have been developed, more particularly the latter. The step piston is the first of the scavenging schemes, and is a scavenging scheme because the volume swept through by the step of the piston may be made larger than the volume swept through by the motor piston proper, and the excess of this displacement is the scavenging displacement. By means of it more air can be put into the motor cylinder per charge than can possibly stay there at atmospheric pressure. This being the case, the burned gases may be more completely expelled, and, what is much more important, the residue of the gases left there would be much cooler before the next compression starts.

This step piston has certain faults of a structural nature which need not be detailed, but which are responsible for the wide use of the alternative scavenging scheme of a separate low-pressure compressor, built somewhat along the lines of the old-fashioned blowing engine. This arrangement is usually double-acting, so that one such scavenging pump will serve two single-acting, 2-cycle motor cylinders. With it the 2-cycle engine can then be made to perform all the things that the 4-cycle engine can do, except as to the negative work involved in the precompression of that surplus air, so that, while the two engines may perform somewhat the same, the 2-cycle form will be necessarily less efficient by the lost or negative work, and, at the same time, some of the so-called simplicity of the 2-cycle engine has disappeared. So completely has it disappeared that it will be found that the weight per horsepower has grown in the 2-cycle to be substantially the same as the weight per horsepower in the 4-cycle. That is to say, when you start with the simple 2-cycle idea with the hope of getting half the weight per horsepower, because of twice the number of impulses from the same amount of metal, then you have to add this and that and the other thing, and by the time you have got through adding enough to make it a real working engine the weights of both types are just about the same. Therefore, the 2-cycle, as compared with the 4-cycle as to weight, might be called substantially equal. But there is an inequality in another direction. The 2-cycle, acting with more impulses per minute in the same volume, will run hotter and load the same sized bearings to a higher average bearing pressure, and, as a consequence, size for size, the 2-cycle will give more trouble with burnt pistons and overheated bearings than the corresponding 4-cycle.

Personal Opinions

These are a few of the reasons why this much-mooted question of 2-cycle versus 4-cycle as a means of air charging remains a controversial matter, rather than one of settled engineering practice. My own personal opinion about the matter is this: That in the smaller size, let us say up to 100 horsepower or 200 horsepower maximum, the simpler form of 2-cycle, not with the separate scavenging pump, is a rather good thing and practical. In the next range of sizes, from, let us say, 500 horsepower, the 4-cycle works out best in the long run, and from that point up the pendulum swings the other way toward 2-cycle with scavenging pumps as matters stand to-day. But in the larger sizes the art is most undeveloped, and most of the uncertainty as to what is the proper engineering practice concentrates right there.

The next item under the functional discussion is the introduction of the oil, to form either an explosive mixture for explosive combustion or to prevent the forming of an explosive mixture so that the oil may burn non-explosively. Before examining the means of introducing and controlling combustion of the oil, I want to point out the fundamental and controlling value of a compression before injection on the one hand, and of the rate of oil burning following the right amount of compression on the other. Consider the former point first. It can be demonstrated, and it is pretty generally understood now

without demonstration, that, other things being equal, the more the air charge is compressed before the introduction of the oil the higher the mean effective pressure will be; and that, of course, is a prime factor in power and, at the same time, the higher the efficiency, or smaller the fuel consumption. It may therefore be said with practically no reservation that in an oil engine as much compression should be carried as is possible. But that is not all. After the compression has been completed the oil must be introduced either at that time or just previously, so as to produce a suitable and proper combustion line of one of the two characteristic types or mixed.

The two characteristic types of combustion line are, first, the vertical combustion line produced by an explosive mixture, and, second, the horizontal combustion line produced by a gradual introduction of the oil, the oil burning as it comes in, and which latter system has been called the Diesel system. It is clear, of course, that we might burn part of the oil explosively, raising the pressure a fraction of the maximum, and burn the rest non-explosively, without further change of pressure. Or we might have such a slow introduction of oil as to cause the combustion line to drop as the piston moves out on the working stroke. The two types of combustion line are (*a*) the vertical explosive, and (*b*) the horizontal non-explosive, or Diesel, forms. Now, of these two methods of oil combustion as to rate, which should one choose? That question should be settled before considering the means of introducing the oil, because one is not warranted in spending time in determining how to introduce the oil until there is first a decision as to what end is to be accomplished by it. In other words, we must establish the specifications before undertaking construction.

Comparison of Diagrams

It will be found, by comparing the full diagrams for those two combustion lines, with the same amount of oil and expansion, of course, following both, that about the same mean effective pressure is possible with both or with either. That is to say, so far as power is concerned, there is no choice. But, on the other hand, when you compare efficiency or fuel consumption, then this startling fact comes out: That the constant pressure or Diesel kind of non-explosive combustion is capable of only half the efficiency of the other kind of combustion, the explosive sort. To put it a little differently and more precisely, if the fuel be burned explosively after compression, then an efficiency can be produced with a corresponding fuel consumption equal to that obtainable with the non-explosive Diesel combustion when the latter has twice the compression of the former. Again, to put it in still another form, a Diesel diagram with nearly 500 pounds compression produces no better efficiency or fuel consumption than an Otto cycle diagram with 250 pounds compression. There is, therefore, absolutely no doubt on fundamental ground as to which of these two possible modes of burning offers the best promise of results. They are equal in power possibilities and nearly two to one in efficiency with reference to compression. When I say the latter, do not misunderstand. Do not think I mean to assert that the Otto can give and always will give twice the efficiency of the Diesel—not at all. They can be made exactly equal in efficiencies and fuel consumptions with selective compressions, but when the compression is thus selected to do that thing it will require twice the compression with the Diesel as will be required with the Otto arrangement.

This is particularly interesting when you consider that fully 90 per cent of all the development work that has been done with this heavy oil engine has been done with the less promising Diesel cycle, and the very promising Otto cycle has been almost entirely neglected. I say it has been neglected, and yet I do not mean that. It has been neglected by those people who understood the possibilities—the students of this subject. It has not attained the popularity or the standing in a commercial way of the Diesel.

In this functional study the next important consideration is the compression itself, and the relation between the degree of compression and the mode of combustion, or control of combustion. The oil has to be ignited, and there are various ways of igniting it. It must not, however, be ignited until the right time comes; that is, not until a sufficient degree of compression has been executed—whatever is desired. Therefore there must be an igniter, and the ignition, as a process, must be under control. Now, the ignition will always take place whenever any fuel in contact with air reaches the ignition temperature. The air under compression is rising in temperature and is approaching or passing the ignition temperature in that process of compression. Somewhere or another in the process of compression, if it be carried far enough, ignition temperature will be established and ignition will inevitably occur, if there is any oil in contact with the air.

It is therefore essential, in considering the limit of compression in its relation to the introduction of oil, to have some kind of mental picture, and preferably exact figures, as to the way in which the temperature rises in compression, especially with reference to the ignition temperature as a basis of reference.

Introducing Some Tables

The ignition temperature of these heavy oils is a somewhat uncertain physical constant, but from my experience I am inclined to think this is very close to 950 degrees F., or near enough to that for practical purposes.

To bring this matter before you, I have prepared a little table here (see table below). This table shows at the left, first column, initial air temperatures of from 200 degrees F. to 600 degrees F. before compression. Starting with these temperatures, then, to reach ignition temperature it would be necessary to have the compressions indicated in columns 2 and 3. To reach temperature of 200 degrees less than ignition temperature the compression would be as shown in columns 3 and 4. To reach a temperature of 200 degrees F. over ignition temperature, the compressions required are shown in columns 5 and 6. Or, for 400 degrees F. over ignition temperature, the compressions of columns 7 and 8.

COMPRESSION VERSUS INITIAL TEMPERATURE VERSUS IGNITION TEMPERATURE (±)

Initial Temperature	Compression, Pounds per Square Inch Above Atmosphere (14.7) with 0.1 Pound Valve Drop							
	Ignition Temperature of 950 Degrees F.		200 Degrees F. Below Ignition		200 Degrees F. Above Ignition		400 Degrees F. Above Ignition	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
200	190	293	104	152	305	511	467	800
300	110	155	58	79	181	279	282	460
400	67	92	34	42	114	165	175	275
500	41	52	18	22	75	101	118	174
600	23	31	8	10	47	63	79	107

$$\text{Based on } S \doteq \begin{cases}1.33\\1.40\end{cases}; \quad P = 14.6\left[\left(\frac{T\text{ final}}{T\text{ initial}}\right)^{\frac{S}{S-1}} - 1\right]$$

To explain further, starting with atmospheric air at a temperature of, say, 70 degrees F. in an engine room, it is drawn into a cylinder and is bound to become somewhat heated on its way. It will become heated by contact with the hot intake ports, sweeping over the intake valves,

sweeping against the interior cylinder walls, which are very hot, especially in large engines with thick metal, and finally it mixes inside with the hot products of combustion from the previous shot. So, to say that this 70 degrees F. will rise 130 degrees F. and have a temperature, therefore, of 200 degrees when compression starts is a very moderate estimate. It is never less than that, and that is the reason I have made this the minimum figure. It might easily be much more than that, especially when it is considered that in some of these engines the interior is red hot in spots. In some of them the whole wall, especially the hot bulb type, is deliberately kept red hot as an igniter. It is quite clear that any products of combustion or air in contact with that red hot spot might easily approach or exceed a temperature of 600 degrees before any compressing is done at all. So I make the temperatures before compression range anywhere from 200 degrees to 600 degrees—and there is even justification for going further.

What Follows When Compression Starts

Now, when the compression starts the pressure follows the general law given at the bottom of the table, and from that certain variations follow; but we are not quite sure as to what value the exponent S has, although we do know it cannot be larger than 1.4. We know by experience it is not less than 1.33. So, for each one of these values I have calculated two figures—the compression pressure in pounds per square inch above the atmosphere —and you see here that to reach ignition temperature with 200 degrees initial temperature would require 190 pounds compression minimum to 293 pounds maximum—actually somewhere between; it is difficult to fix it any closer. Whereas, if the initial temperature was 600 degrees, then the ignition temperature would be reached in that same cylinder with a compression of only 23 pounds to 31 pounds. That brings out in the most striking fashion this fact: That if the fuel is in contact with the air in the cylinder during compression, then the amount of compression cannot be very large in any case without producing an uncontrolled pre-ignition. And, more important still, if any part of the oil and air is very warm before compression starts, then practically no compression can be carried at all. And, if you cannot carry much compression, then you have a very high fuel consumption and a very low efficiency. An engine carrying such low compressions as are here required would burn nearly 2 pounds of oil per hour per horsepower, whereas the best engines are to-day running on about four-tenths of a pound—a ratio of five to one.

Now, suppose an igniter that was itself under control, and fuel in contact with the air in the cylinder. How much can we compress it without any danger of preigniting it, so that when we want to fire it can be fired with the igniter that is under control? I suggest that 200 degrees margin is about as good as can be estimated. Let us limit the final compression temperature to something like 200 degrees under the ignition temperature, in which case these are the allowable compressions: With 600 degrees initial temperature, the final compression pressure is 8 pounds to 10 pounds; with 200 degrees initial temperature, 104 pounds to 152 pounds (see table).

On the other hand, suppose that the system was such as the Diesel, where the air temperature itself is to serve as the igniter. In that case, to insure ignition, we should have a margin of about 200 degrees in the other direction; that is to say, the air should be compressed to a sufficiently high pressure not only to produce ignition temperature, but 200 degrees more, in which case the last two columns give the compressions that are necessary. Should the oil now be introduced into the cylinder by means of compressed air to make a fine spray and scatter it through the charge of air, in accordance with the general practice, then it must be remembered that this air jet which is doing the spraying and the scattering is itself exerting a cooling action. Consider 1,000 pounds or 1,200 pounds pressure of air expanding through the spray valve into a cylinder with about 300 pounds or 400 pounds or 500 pounds compression pressure, and it can readily be seen that there is a very considerable cooling action right at the jet. That it will act to prevent ignition and to make sure that the oil will ignite in spite of such cooling influence at the point of oil injection, it is necessary to carry the compression still higher. Let us provide at least 400 degrees over ignition temperature, in which case, with an initial temperature of 200 degrees, we would require something between 467 pounds and 800 pounds compression. With 600 degrees initial temperature we could secure this 400 degrees above ignition with anywhere between 80 pounds and 100 pounds compression.

These figures should be made the subject of some study and be used in considering the various structural arrangements, because in them will be found a key to the question: Why cannot this type of engine—this arrangement —be efficient? And why is the other arrangement highly efficient? Here also will be found the key to the question of how we should proceed to make the less efficient one more efficient. These three elements stand out:

First, is the fuel in contact with the air during compression, or is it not?

Second, if the oil is in contact with the air during compression, is the region of contact all of low temperature, all of high temperature, or any part of it a high temperature region when the compression starts? The initial temperature has a great effect on the degree of compression needed or permissible.

Third, if the oil is not in contact with the air during compression, but has to be introduced subsequently, how should it be introduced with reference to the igniter? If the air itself is to be the igniter, then a certain high value of the compression must be obtained, or the engine will not run. If the air itself is not to be the igniter, then what kind of an igniter can we provide? We will look into that question.

All the first oil engines to attain commercial success had vaporizers. That is to say, there was some element the duty of which was to heat the oil alone for later air mixing, or to heat the oil and air together, to produce a vapor air mixture. It matters very little as to what were the details of those arrangements—whether one produced a heavy carbonizing action and another did not. They are all one as regards this point of controlling importance: The mixture when formed by any such vaporizing system is necessarily a warm or a hot mixture. Just how hot it has to be depends upon the vapor pressure of the particular oil, or rather the heaviest constituent of that particular oil, and I will give some figures to make it clear. A 60-degree Baumé gasoline vaporizing in air requires a temperature of about 100 degrees to 110 degrees. The ordinary lamp kerosene of 150 flash point vaporizing in air requires a temperature of 250 degrees. A navy fuel vaporizing in air requires a temperature of 420 degrees, and so on. One could go on with any grade of oil or residue; for each there is some temperature at which the vapor of the oil can be produced in the right proportions for combustion and in contact with its air, without residue and dry.

(To be continued.)

Concrete Boats Built by the Aberthaw Construction Company

WITH an experience of twenty-five years of reinforced concrete construction behind them, the Aberthaw Construction Company, Boston, Mass., has entered the marine field and established a concrete shipbuilding yard at Fields Point, Providence, R. I.

The vessels now actually under construction are 500-ton lighters, with plans under way for others of larger and different type. The lighters now in the building are 112 feet overall, with 34-foot beam and 11 feet 6 inches depth. The draft, empty, is 3 feet 9 inches, and, fully loaded, 9 feet.

The deck of the lighter, which is without camber, is designed for carrying coal or a similar cargo and is constructed to take a uniformly distributed live load of 500 pounds per square foot, while the compartments themselves are well adapted for handling fuel oil. Each of the fifteen compartments is fitted with a hatch set in an iron frame furnished with rubber gasket and suitable provision for battening down. To assist in holding the deck load, a timber bulkhead is built enclosing an area of 90 feet by 30 feet. The side bulkheads are 2 feet high and end walls 5 feet in height.

The outside shell and deck are each 3 inches thick and reinforced with round deformed bars of the corrugated or Havemeyer type. The bottom slab and frames are de-

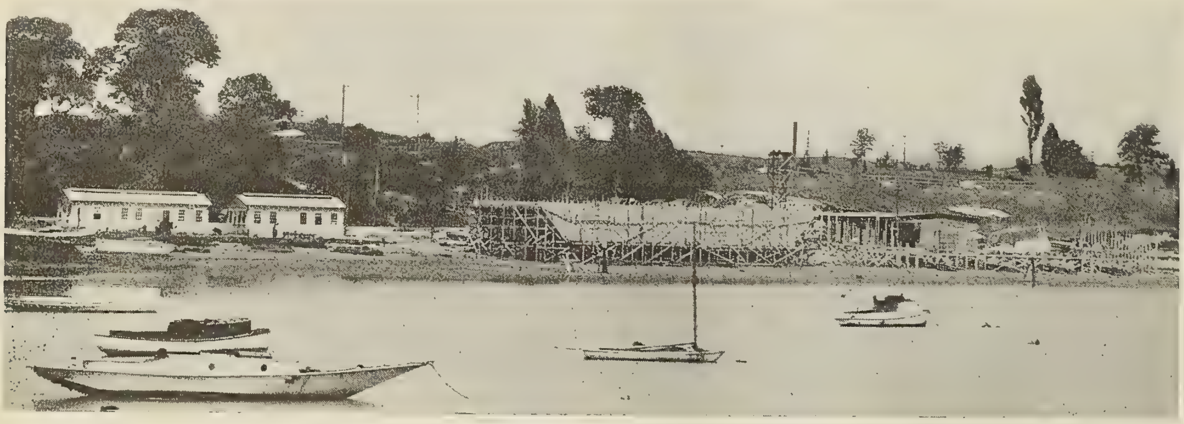


Fig. 1.—Yard of the Aberthaw Construction Company

The general shape of the barge is that of a rectangular box with the bottom sloping upward at each end and the corner formed by the junction of the sides and bottom rounded off to a 6-inch radius. Four transverse and two

signed to carry an upward pressure of water equal to a head of 11 feet 6 inches, and the side walls and frame are designed on the assumption that the water might be flush with the deck. The sides and bottom are painted on the

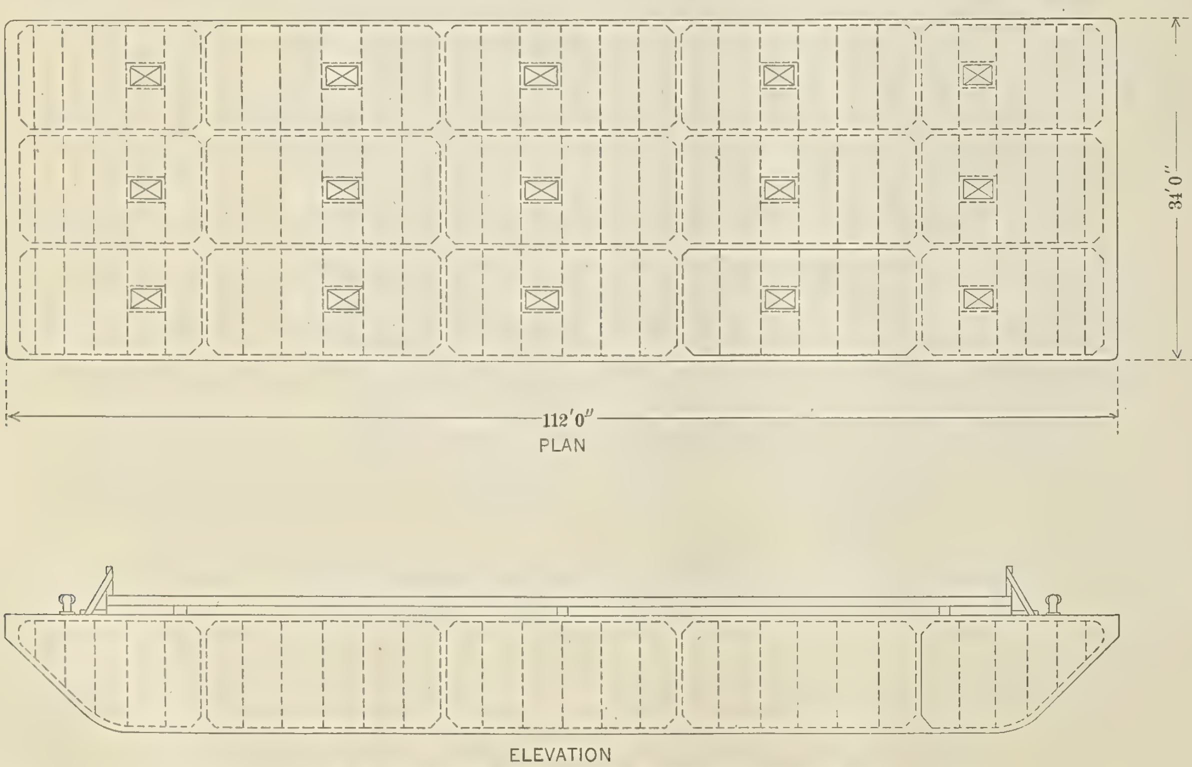


Fig. 2.—Plan and Elevation of Aberthaw Concrete Boat

longitudinal bulkheads divide the lighter into fifteen watertight compartments of approximately equal cubical capacity.

outside for greater impermeability, and the sides and ends are protected by hardwood fenders and chafing strips. The decks are granolithic finished.

All steel used for reinforcing is of mild structural grade, that used for the longitudinal girders being in one continuous length, butt-welded where necessary, care being taken that the welds are staggered, so that no two welds are within 40 inches of each other. The bars for the transverse frames are made continuous in like manner. All intersections of bars are fastened with soft annealed wire, which is wrapped around and tightly twisted.

The concrete is mixed in portions of one part Lehigh Portland cement, one part sand and two parts stone, the cement being of such a grade that ninety percent will pass through a No. 200 sieve, no aggregate being used exceeding a size that would pass a ⅝-inch ring; the sand being sharp, clean, bank sand, free from all dirt or vegetable matter. Each barge requires 500 barrels of cement, 75 cubic yards of sand and 130 cubic yards of ½-inch stone, together with approximately 44 tons of reinforcing rods ranging in size from ⅜ inch to 1⅛ inches.

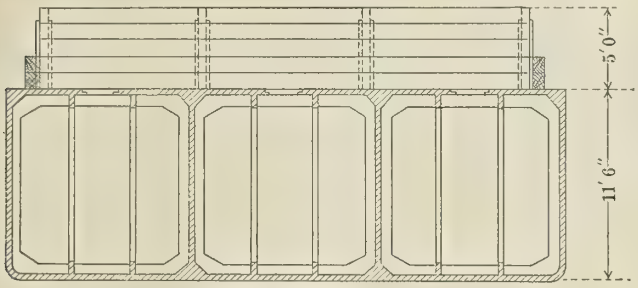


Fig. 3.—Midship Section

The barges are fitted with cast iron chocks, cleats and bollards, the majority of the balance of the hardware used being galvanized. Bitts and fenders are of oak, the remainder of the woodwork being hard or long leaf yellow pine, dressed on four sides. On the sides at either end is the "Aberthaw A" in brass, a mark that represents twenty-five years' experience in reinforced concrete construction.

Take a mailing tube, say, 18 inches long and two inches diameter. Put your mouth at one end and blow through it and feel the effect of the blast on your hand at the other end. Now hold the tube about an inch from your mouth and blow into the end of the tube. You will be surprised to feel the increase of the effect at the other end.

This experiment illustrates the principle of the Jeffrard injector, brought out by that Frenchman in the fifties of the last century. The scientific world called him crazy and all said the injector would not work; but it does.

Take this mailing tube and try to twist it, holding it at each end; now slit it from end to end with your knife and again try to twist it. This experiment will give you a better lesson in the value of forms in resisting strains than the best *x* chaser can show on one thousand sheets of paper. Just try it.

Men have been known who could put a keen edge on a tool but could not do a job with sharp tools. The tendency of to-day is to find out what a man can do best and keep him at that job. In war times this is not only wise but necessary. In times of peace a single operation man makes for low mentality, and low mentality is a detriment to an individual and to the nation. Low mentality is not governed by reason but by personal comfort. A well-fed mob soon fades away. The agitator knows that the way to set a crowd doing things is to point out what they want, to tell them where it is and to go and take it.

Admiral Sims Urges Shipyard Workers to Speed Up Construction

Vice Admiral Sims, commanding the United States naval forces operating in European waters, insists that we must have more and yet more destroyers. Do the men who actually build the boats understand how vitally important is speed in building? he asks; do they understand that we will win or lose according to whether we beat the submarine or it beats us; that we must depend chiefly upon destroyers for this—to protect merchant vessels and attack the submarines; that a destroyer is worth nothing while in America; that she will be useless if she arrives here too late; that destroyers on this side now are worth their weight in gold?

Do they understand that if *every single man* could speed up *his own work*, every riveter strike more blows per hour, every handler of machines, metal, tools, etc., save every second of time, we could get our ships in service in very much less time and thus hasten the end of the war?

This applies equally to the great force of men who are building the new merchant vessels. Their work is just as important in beating the enemy as that of the men in the trenches. The soldiers cannot win unless they are supplied with food and guns and ammunition, and this can be done only by ships.

The point is that every man should feel that every blow of his *own* hammer is a blow at the enemy; that a certain number of blows will put the enemy down and out; and that the sooner all these blows are struck the more valuable lives will be saved and the sooner we shall have peace and plenty.

If our yards will rush the ships and destroyers, we may rely upon the Allied navies and armies to do the rest.

Many a man loses interest in his work in the fireroom when he sees that his work is never recognized. A little encouragement is wise. Go down into the boiler room now and then and say a word of appreciation to the man with the shovel. If he is not worthy of it, fire him instead of letting him fire.

Oil in a boiler, all know, does harm, but just why is not usually understood. Oil of itself does no harm on a metal surface; in fact, it is well known to preserve it. However, when oil lies on a metal plate exposed to heat the oil turns into a deposit of carbon and so intervenes between the plate and the cooling effect of the water. It is this condition which destroys the plate.

Years ago alchemists were constantly searching for the touchstone which would turn all metals into gold, or for a universal solvent—a something which would dissolve anything. These men never seemed to get the idea that the more gold there is the less it is worth, or to wonder in what they would keep the universal solvent if they found it.

A fireman who had been at sea applied for a job of running a boiler in an apartment house. He said to the owner, "Although my hair is gray, I am as fit as ever I was, but most men don't want a gray-haired man around."

The proprietor replied, "I hire a man for what is in his head, not what is on it."

That was a wise man indeed.

I can call spirits from the vasty deep. Oh, but will they come?

I can drive rivets by the thousand feet. Oh, but will they stay?

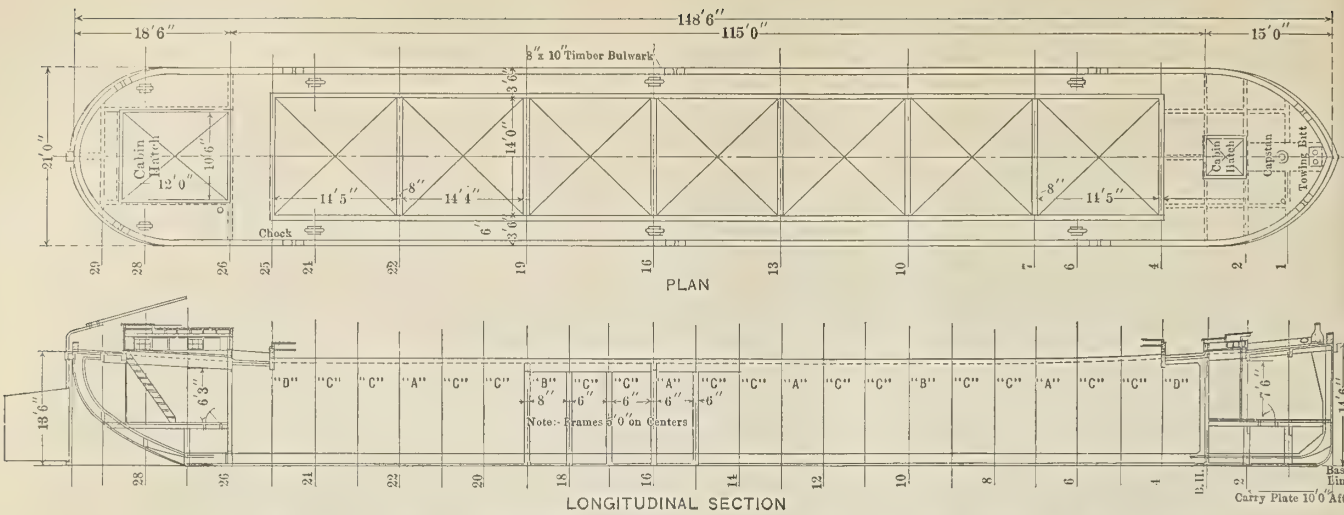


Fig. 1.—General Arrangement Concrete Barge. Length, 150 Feet; Beam, 21 Feet; Depth at Sides, 12 Feet

Standard Concrete Barge for Use on the New York State Barge Canal

Authorized Design for Service on State Canal—Unusual Refinement of Concrete Used—Plans and Specifications

PURSUANT to their policy of issuing completed plans to the shipbuilding industry, the Emergency Fleet Corporation has again come forward with drawings and specifications for the construction of a standard concrete canal barge for use on the New York State Barge Canal.

The boat is 150 feet long, 21 feet beam, and 12 feet depth at the sides. It has a load draft of approximately 9½ feet; a displacement, loaded, of 756 tons, and a deadweight carrying capacity of about 489 tons. It is of the open hull type, with cargo hatches 14 feet wide, leaving 3½ feet deck space on each side.

For most of its length the hull is practically square, with a rounded bow and ship-shaped stern. The main frames along the bottom are 6 by 18-inch girders, with square bar reinforcement in upper and lower planes connected by small bar stirrups. At the sides the frames are 6 by 12-inch girders, turned at the deck and extended to the hatch coamings. Every fourth frame is carried across the hatches as a cross brace.

The barge has a center and two side keelsons forming the longitudinal stiffeners, and side frames of normal reinforced concrete girders spaced 5 feet on centers and carrying an outer single shell. Except forward of the forward bulkhead, where the shell is 4½ inches thick, and

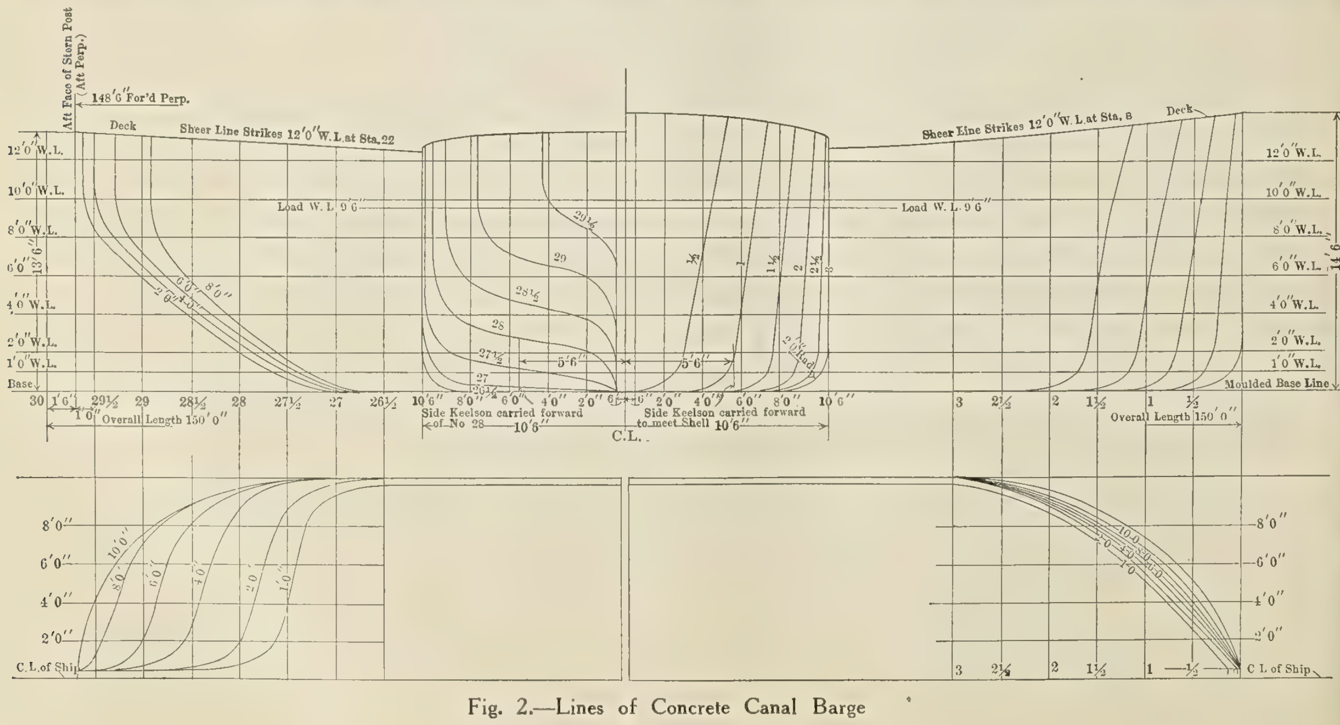


Fig. 2.—Lines of Concrete Canal Barge

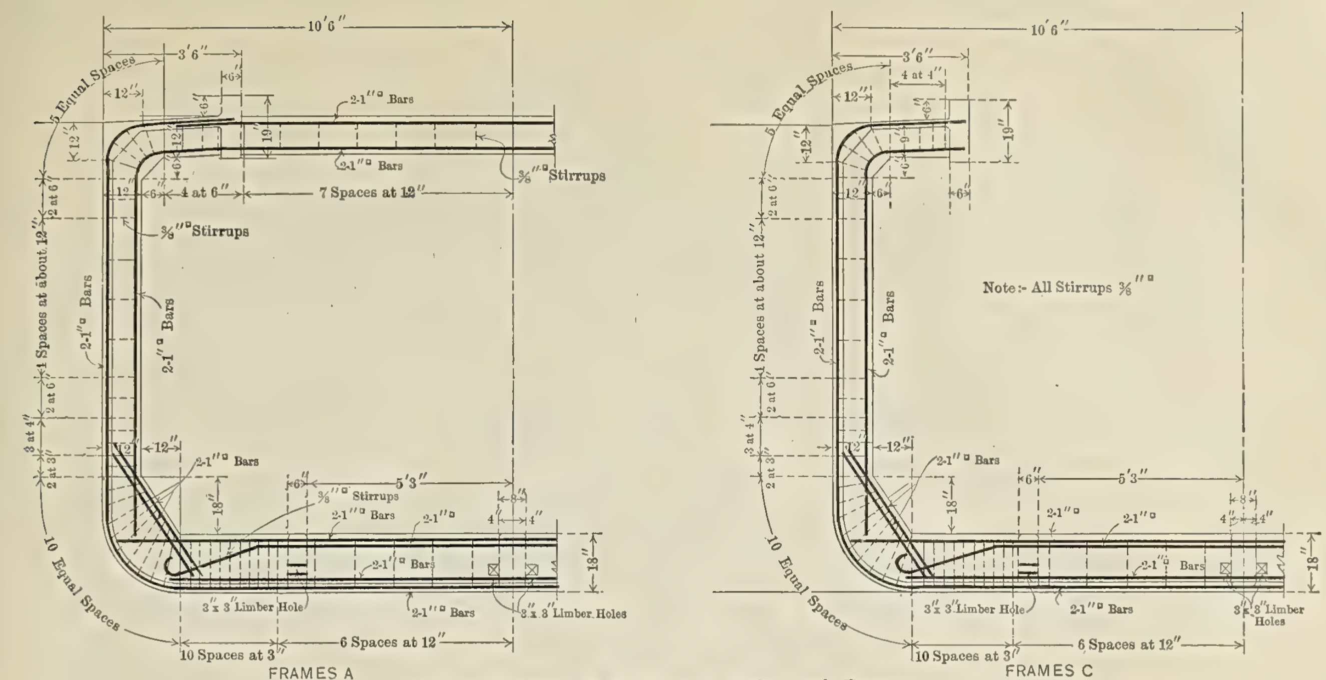


Fig. 3.—Middle Body Frames, Sides and Bottom

aft of frame 26, where it is 4 inches thick, the shell is 3 inches thick, as is also the deck slab. Both the shell and deck slabs are reinforced with ½ and ⅜-inch rods running horizontally and variously spaced, according to the location in the shell or deck. There are also ½-inch vertically running shear rods spaced 7 inches center to center. At the turn between the side and the deck, the shell is further stiffened by a number of longitudinal rods.

All horizontal steel in the sides on the midship section is carried around the bow and stern. The steel in the bottom and bilge is carried forward and aft as far as possible without interfering with the steel from the sides. A transverse bulkhead, consisting of a 3-inch vertical wall bearing against three 7-inch vertical girders which frame into longitudinal deck girders, is provided 15 feet from the bow.

In the hold a wooden floor consisting of 4-inch plank is laid across the frames and extends up the sides to the under sides of the deck. The hatch covers are timber frames which can be lifted off the seat and are made up of 6 by 8-inch yellow pine timbers bolted to the reinforced concrete girder forming the hatch coaming.

Cabin and storage spaces are provided in the bow and stern. The flooring in these spaces consists of ⅞-inch tongued-and-grooved white pine laid upon one layer of ⅞-inch sheathing with one thickness of building paper between. The flooring beams are 2 by 6 inches of yellow pine spaced about 16 inches apart. The siding inside is of yellow pine, ⅞ by 3-inch tongued, grooved and beveled, laid horizontally with molding at under side of windows. The corner posts are of rounded yellow pine. The top of the house is constructed of 2-inch tongued-and-grooved yellow pine planking. The doors are 1½ inches thick, framed, of panel inside and outside, and hung with brass hinges fitted with locks and knobs, staples and buffers.

There is a wooden stairway leading from the deck to the cabin door, and the cabin is provided with a stove stand, properly insulated with ⅜-inch asbestos and sheet metal, and a sink and lockers, shelves and bins.

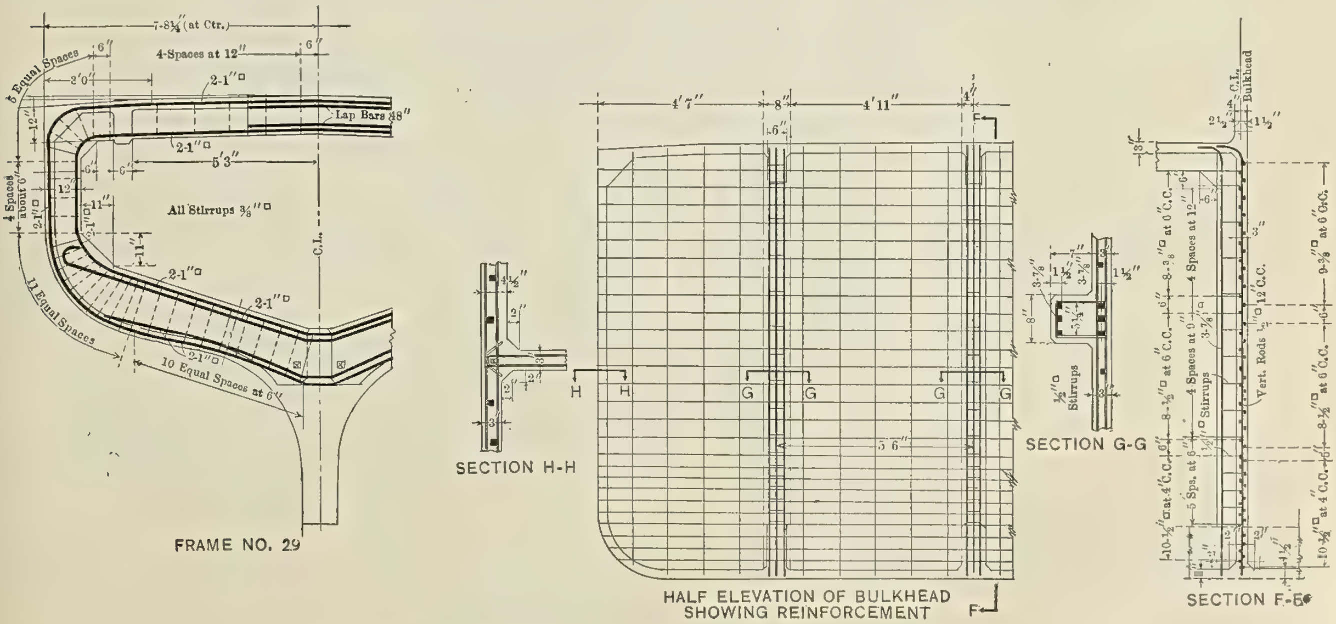


Fig. 4.—Some Sections and a Half Elevation Showing Reinforcement

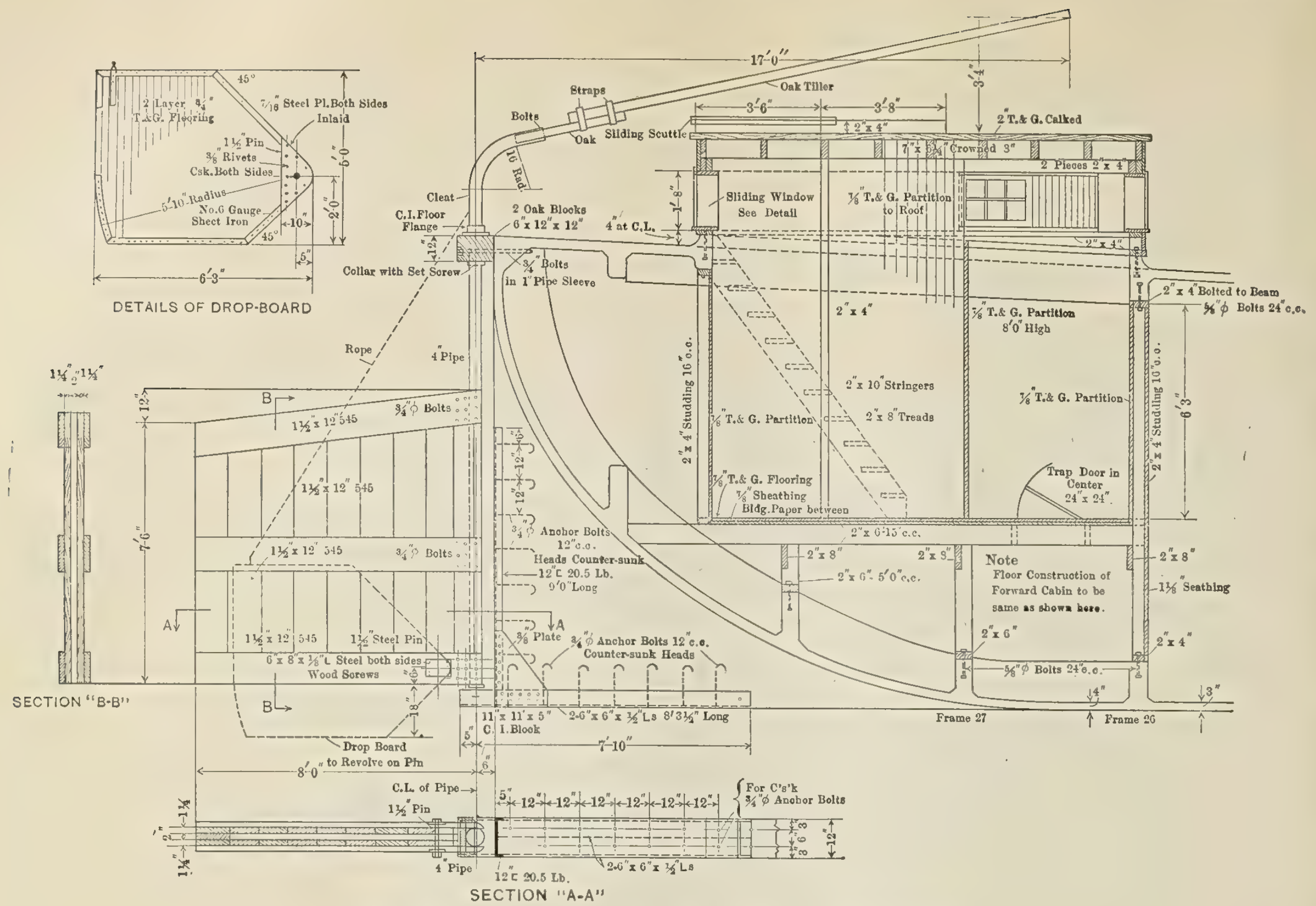


Fig. 5.—Details of Drop Board and Design of Rudder Posts

Spruce, oak and yellow pine enter into the construction throughout, and the concrete used is of somewhat unusual refinement. It is to be ground to such a powder that the residue through a standard 200 sieve shall not exceed 10 percent by weight. This is called for in the hope of getting a high strength concrete with a minimum of delay. Concrete for the slabs—that is, for the deck, bulkhead and shell—is to be mixed in the proportion of one sack of Portland cement, 2/3 cubic foot of fine aggregate, and 1 1/3 cubic feet of 1/4-inch aggregate. For the frames, a concrete can be used consisting of one sack of Portland cement, one cubic foot of fine aggregate, and 2 cubic feet of 1/2-inch aggregate. Continuous concreting is to be carried out if possible. In case a joint is found necessary, one only will be allowed, and this on a line 2 feet below the deck of the barge.

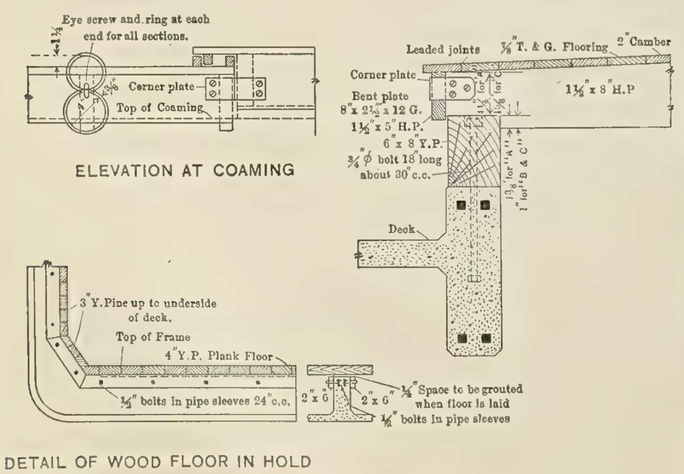


Fig. 6.—Details of Coaming and Wood Floor

Post Commandants Needed for Junior Naval Reserve

The U. S. Junior Naval Reserve, which is doing such splendid work in the training of American boys for sea service, are preparing to organize a State council in every State for the purpose of extending the organization of local posts into every town. Just now they are looking for men who are willing to serve as post commandants. Retired navy or army officers, or draft exempt men with military training, would make good men for post commandants. All applications should be addressed to Mr. Edward A. Oldham, executive secretary, U. S. Junior Naval Reserve, National Headquarters, 218 West 58th street, New York.

A syphon is a mystery to some, as they cannot see how water can run up hill. It does not. It is forced up the short leg of the syphon tube by the weight of the air and then runs down the long length by gravity. There are no mysteries in nature.

"Almost a pound" is all right for one pound but when it comes to a large number of pounds it is another matter. Wood screws are sold by the length and number, the latter referring to the size of wire used in making them.

Large profits are possible on small transactions; small profits generally go with large deals. No one will get poor taking even very small profits; but they must be real profits and not book profits.

Stress Distribution in Bolts and Nuts*

**Character and Analysis of Strains in Butt Straps—
Instrument for Ascertaining Difference in Thread Pitch**

BY C. E. STROMEYER

THIS subject is at present of considerable importance, partly because it is desirable to be able to compare the merits of the coarse and fine screw thread standards, and partly, as will be seen, because modification in the several standards might materially improve them, both as regards strength, reliability, and usefulness. It seems desirable, therefore, to bring this inquiry to the notice of marine engineers, who use bolts for a diversity of objects.

The problem is related to that of riveted joints. In 1885 Mr. J. T. Milton mentioned some experiments (Transactions, Institution of Naval Architects, volume XXVI, page 204) which showed that riveted seams with three rows of rivets were relatively weaker than those having only one or two rows. The subject was discussed in my work on boilers, and recently Professor Batho has measured the strains in the butt strap plates between successive rows of rivets (Franklin Institute, 1916, volume 182, page 553).

Character of the Strains

This problem is a comparatively simple one, especially if, as in Fig. 1, the two butt straps are assumed to be in compression, in the same way as a nut is in compression. These butt straps rest on a platform E, and the central plate is subjected to a pull P_0, which is also the tension stress if the plate section is unity. Starting at the top of the structure there is a force P_1, acting on the rivet A, which produces a deflection and results in a slight relative displacement, $a_1 = z \cdot P_1$, between the inner and outer plates. At B we have the displacement $a_2 = z \cdot P_2$, etc., where z expresses the amount of elasticity or give of the rivet in its three holes. The elongation of the center plate between A and B is $b_1 = e \cdot P_1$, where e is the elasticity of the plates. The contraction of the outer plates is also b_1. Therefore $2 \cdot b_1$ is the excess displacement at B over that at A, and we have generally:

$$a_1 = z\,P_1; \qquad b_1 = e\,P_1$$

$$a_2 = a_1 + 2b_1 = z \cdot P_1 + 2 \cdot e\,P_1 = z \cdot P_2; \qquad b_2 = e\,(P_1 + P_2)$$

$$a_3 = a_2 + 2b_2 = z \cdot P_2 + 2 \cdot e\,(P_1 + P_2) = z \cdot P_3; \qquad b_3 = e\,(P_1 + P_2 + P_3).$$

These expressions can easily be combined and then give:

$$P_2 = P_1\,(1 + 2 \cdot e/z)$$

$$P_3 = P_1\,(1 + 2 \cdot e/z)^2 + 2 \cdot \frac{e}{z}$$

$$P_4 = P_1\,(1 + 2 \cdot e/z)^3 + 2\left(2 \cdot \frac{e}{z}\right)^2 + 6 \cdot \frac{e}{z}$$

The tensions in the center plates are successively P_1; $P_1 + P_2$; $P_1 + P_2 + P_3$; $P_1 + P_2 + P_3 + P_4 = P_0$. When the summation is carried out, the problem is solved in terms of P_0, provided that the ratio of the elasticities e and z are known.

Instead of rivets passing through the plates, we can provide both the center and outside plates with V-shaped projections; these plates can be made of celluloid and stressed while being illuminated by polarized light, which, as has been shown by Professor Coker (Transactions, Institution of Naval Architects, 1911, volume LIII, part 1, page 265), reveals the nature of the stresses. This idea has been beautifully carried out by Mr. Rowland, of the Technical School, Leicester, who has kindly sent me a copy of one of his photographs (Fig. 3). This photograph shows very clearly that certain stresses under the roots of the threads increase quite steadily from the top thread to the bottom one. It does not seem possible as yet to measure the stresses accurately, but, roughly speaking, the shear of each thread section is proportional to the area bounded by the dark bands. These areas increase approximately, as indicated above. If it should be found that the agreement between experiments and the above theory is a fairly close one, then it is very probable that the results of the following investigation, which are based on the same principles, deserve being looked upon as reasonably safe guides with regard to the stress distribution in bolts and nuts.

A screw is, of course, not a series of teeth, but we might make a number of half-sections of plates of the pattern in Fig. 2, place them side by side, but slightly

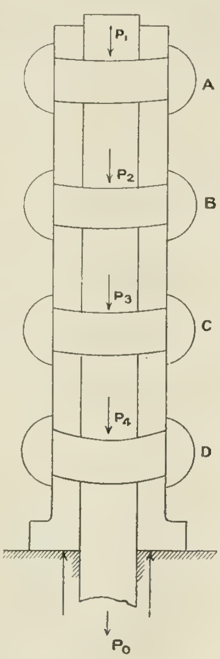


Fig. 1.—Butt Straps

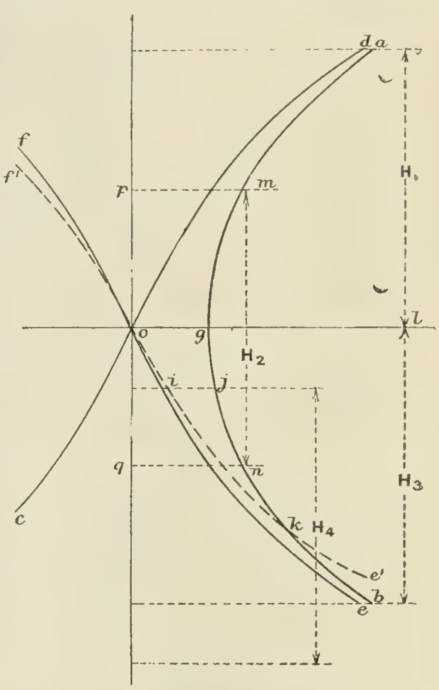


Fig. 2.—Stress Results

staggered, combine the lot and bend the combination till the two ends meet; then we have a bolt and nut in which the steps can, by subdivision, be reduced to smooth threads.

As might be expected, the mathematical treatment of this problem led to an exponential curve of the form $a \pm bx.$, which is what would be obtained in the butt strap problem, if the successive rivets were infinitely close together, in which case the terms outside the brackets would disappear. But it was felt that the possibility, or rather the certainty, that the thread pitches of the bolt and nut

* From a paper read at the spring meetings of the fifty-ninth session of the Institution of Naval Architects, London, March 21, 1918.

would not always be exactly the same should be taken into account. This has been done, and the result is most interesting, as will be seen from Fig. 2, which represents the shearing stress distribution over the height of the nut. For the case in which the pitches of the two threads are exactly equal, the stresses are represented by the horizontal distances between the curves *o d* and *g a*, the height of the nut being *H*. It will be seen that the stress at the bottom of the nut *o g* is very much greater than at the top *a d*.

Stress Distribution in Nuts

Assume now that the nut is being elongated slowly, due, for instance, to its being warmed, the bolt remaining cold, then in Fig. 2 the line *c o d* will slowly swing round against the clock and also straighten itself out, while the nut, whose original position was *H*, will slowly move downwards. The *b g a* curve remains stationary. When the expansion, and therefore the excess pitch, $1/n$ amounts to exactly the ratio of the tension stress in the bottom of the bolt to the modulus of elasticity, then the *c o d* curve will be the straight line *q o p*; the position of the nut will now be H_2, and the stress distribution will be represented by the horizontal distances between *q o p* and *n g m*. It will be seen that the stress distribution is now a fairly even one, the stresses at the top and bottom of the nut being equal. The condition, however, is not the most favorable one, because these shearing stresses combine with the tension stress in the bolt, and there would still be a relatively severe resultant stress at the bottom level of the nut, the very point where the stresses should be reduced to a minimum.

Allowing the expansion of the nut to continue till the excess pitch is twice as much as in the last case, then the *c o d* curve will have swung round to the position *e o f*, and the nut will have sunk to the level H_3. The stress distribution is now exactly the same as in the first case, except that the maximum stress is at the top level of the nut, where, if a fracture should occur, the harm done would not be serious.

If the difference of pitch be increased still further, or if it be reduced to less than in the first case, i. e., if the nut had originally had a finer pitch than the bolt then the stress distribution would be a triangular one, as indicated by the outline *i j k*. Beyond *K*, down to the bottom of the nut H_4, the threads would not be in contact. The stress *i j* would therefore be very severe. If the nut has a finer thread pitch than the bolt, this very severe stress would be situated at the bottom level of the nut, and would cause cracks, fractures, or stripping of threads.

Failure 1.—This conclusion was confirmed by the failure of several successive piston rods of some large horizontal gas engines. The rods were 12 inches diameter and hollow. The screwed part was 11 inches diameter, pitch four threads per inch. Several of these rods had broken just inside the nut, others stripped their threads. Of these, unfortunately, only one was seen; its nut thread pitch was 1/1000 finer than that of the rod. The gas pressure and the inertia stresses in the rod were estimated to be about 2½ tons, but according to my present estimate the maximum stresses under the roots of the threads would be about ten times greater, or about 25 tons per square inch. No wonder that the threads gave way!

Failure 2.—Some main bearing bolts had failed frequently almost as soon as they were renewed. They were not subjected to excessive loads, and the metal—steel—was found to be quite satisfactory. Subsequently, in view of the above-mentioned experience, the threads of one fractured bolt and its nut were compared, when it was found that the nut thread, a fairly coarse one, was 4/1000 finer than the bolt thread pitch. In this case my estimate was that the stresses under the roots of the threads exceeded 30 tons.

In case of future failures, it would be very desirable to ascertain whether there is a difference of thread pitch. This can easily be done with the help of the simple instrument shown in Fig. 4. Two bars, *B* and B_2, are placed one on top of the other. Two U-frames, U_1 and U_2, are attached to B_2. The one has an ordinary set screw, C_1, the other has an elastic one, C_2, shown in section with its enclosed spring. A dial *D* is attached to U_2 and two pins, P_1 and P_2, are screwed into the ends of the bars B_1 and B_2. These pins are pressed into the screw threads of the nut

Fig. 3.—Photograph Showing Stress at Root of Threads

N. C_1 is now screwed down lightly and the instrument is removed. At the *D* end, B_1 and B_2 are separated slightly and a fine rolling pin *R* (steel wire of about 0.01 or 0.02 inches diameter) is inserted. Its pointer traverses the dial *D*. The instrument is now replaced, C_2 is screwed down, and C_1 slacked back, while the pins p_1 and p_2 are pressed into the threads. A reading is then taken on the dial *D*. The instrument is then transferred to the bolt, C_1 being temporarily tightened, and another reading is taken. The difference of the readings divided by the distance p_1, p_2 is the difference of the two pitches. These readings can easily be taken to ten-thousandths of an inch. Such an instrument can easily be made by any mechanic, and would be found useful for many purposes.

It would take too long to discuss the results of this investigation as fully as the subject deserves. Therefore, only a very brief reference will be made to certain of the final results. It should, however, be borne in mind that these numerical values have only a comparative value until they have been confirmed by experiments like those which Mr. Rowland is now carrying out. For ordinary practice, in which the pitches and the thread shapes are

supposed to be alike, coarse bolts similar to the Whitworth practice for 1-inch bolts are associated with lower stresses than the Seller bolts of the same proportions, the ratio of the estimated stresses being as 3.08 to 4.07. A change to medium fine pitches hardly reduces the stresses, and very fine ones (32 per core diameter) actually increase them, although the stress in the body of the bolt is reduced from 1.56 to 1.13 by the adoption of the finer pitch.

If by chance the nut thread pitch is finer than that of the bolt, then the Whitworth bolts improve their position still more. If they are coarser than the bolt threads, the improvement is shared by all screws. This improvement is very marked except with the very fine threads, which hardly improve. In all these cases the maximum stress is transferred from the bottom of the nut, where it is dangerous, to the top, where even if a thread should strip there are others to take its place. By this change the above-mentioned stress of 3.08 at the bottom of a Whitworth bolt is reduced to 1.74, while the stress at the top does not rise above 2.16. For very fine threads the relative stresses are 3.34 for equal pitches and 1.15 and 2.73 for the unequal ones. For Seller's threads they are 4.07, 1.76 and 3.21.

Another point in favor of relatively coarser pitch of nut thread than bolt thread is associated with the tendency to slack back. With equal pitches for bolt and nut the maximum pressure will be at the bottom of the nut, and will probably produce a kink in the thread of the bolt at the bottom of the nut, which kink, if vibrations occur, will hammer against the bottom nut thread and start a slacking back process. If the nut thread be made coarser than the bolt thread the kink will be at the top, and, instead of starting a slacking back process, it opposes it even if started.

As regards thread angles, fine ones like the B.A. shape, especially if the pitch is a coarse one, have the advantage that their elasticity leads to a relatively uniform stress distribution over the height of the nut. The advantage of heavy truncations, as in the Thury standard, in which the roots of the threads are very wide, is that the very intense stresses under these roots are spread out over a relatively large area and are thereby reduced.

A seriously disturbing factor is the difficulty on the part of manufacturers to make the thread shapes perfectly correct. For instance, taking a 1-inch Whitworth bolt, the flat parts of the threads measure about 1/16 inch, and an error of even 1 degree in the slope angle affects the dimensions by only 1 ÷ 1,000 inch, which can hardly be detected, and when chasers, taps and dies wear out, the angles undergo even larger changes. It is therefore a common occurrence for the nut thread to have either a finer form than that of the bolt in which its crest will be resting close to the root of the bolt thread, which is a very favorable condition, or it may happen that the nut thread is of a relatively blunt form; possibly, too, it may by accident be tilted upwards—worn-out nut—then its root will bear on the crest of the bolt thread and the stresses will be two and three times severer than in the last case.

As these misfits are of constant occurence—even the large-scale celluloid model, Fig. 3, was not perfect—engineers have to provide against these worst cases by using relatively large bolts. A great improvement should be possible by using the Seller slope of 30 degrees for the bolt thread, and the Whitworth slope of 27½ degrees for the nut thread, for then the errors would have to exceed 1¼ degrees before improper loading occurs.

Being limited for space, this paper had to be made as short as possible. This explains why many interesting side issues have had to be avoided, and why several suggestive modifications which have been made could not be discussed in detail. It is hoped that despite the difficulties under which the paper has been written some of its indications will prove to be of immediate advantage to designers of marine engine parts.

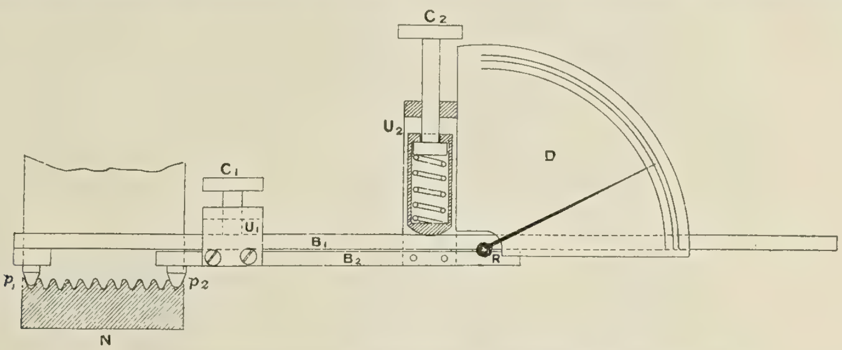


Fig. 4.—Instrument for Ascertaining Difference in Thread Pitch

Among these indications there is one to which no direct reference has been made in the body of the paper, not because it is unimportant but because to mention it would have withdrawn attention from the elementary principles to which it was intended to confine the paper. This subject may be briefly indicated by the following remarks. Every practical engineer knows that mild steel is a very reliable material. It is exceptionally plastic, and when subjected to complicated severe stresses, more particularly if they are confined to microscopically minute localities, it will take minute local sets, which effectively ease the situation by equalizing stresses. If, however, we wish to employ high tenacity steel, and the tendency in that direction is both strong and justifiable, at least for small bolts, severe stresses, no matter how concentrated they may be, will produce minute cracks or will at least produce local brittleness. If these cracks or deteriorations occur near the bottom levels of nuts, they are unquestionably extremely dangerous. If, therefore, high tenacity steel is to come into more general use for bolts, these severe stresses must be reduced or they must be shifted to the top levels of the nuts. One very effective move in the direction of equalizing stresses has already forced itself on engineers who have found that mild steel nuts must be used with high tenacity steel bolts, the explanation being that their threads take permanent sets at stresses which are lower than those which would produce cracks in the roots of high tenacity steel bolts. Other promising alternatives do not seem to have been tried.

A drop of oil will often prevent a squeak but it may take a gallon to stop its squeaking.

Investigation of the Shearing Force and Bending Moment Acting on the Structure of a Ship, Including Dynamic Effects*

BY A. M. ROBB, B. SC.

THE proposed vessel treated in this investigation is of the intermediate, cargo-and-passenger type, having the following general particulars:

Length between perpendiculars, 340 feet; breadth, molded, 50 feet; depth, molded, 29 feet; draft load, 19 feet; displacement at load draft, 6,200 tons; block coefficient, .67.

Two conditions of loading having been considered, the "standard hogging" and the "standard sagging" conditions. The particulars of these are given below:

	Standard Hogging	Standard Sagging
Hull and machinery	3,200	3,200
Cargo forward	1,065	1,065
Cargo aft	705	705
Fuel	.....	620
Fresh water amidships	.....	261
Fresh water aft	56	.....
Stores amidships	.....	55
Stores aft	10	.....
Baggage and mails	.....	30
Passengers	15	15
Water ballast forward	72	.....
Total tons	5,120	5,950

Statical Calculations

In the first place the ordinary hogging and sagging shearing force and bending moment curves were drawn. It was then decided to trace the variation of shearing force and bending moment as the ship traversed the waves, assuming her to be in statical equilibrium in each successive position. Accordingly, five further positions of the ship on the wave were taken, each being one-sixth wave length in advance of the preceding one. The successive positions of the ship on the wave are shown at the top of Figs. 1 and 2. The weight curves are also shown, and below the weight curves the series of buoyancy curves; each buoyancy curve is numbered to correspond with the position of the ship indicated above. The shearing force and bending moment curves, shown below the buoyancy curves, are also numbered to correspond with the positions of the ship indicated above.

It is interesting to note that the "standard" curves, marked "1" in each case, practically envelop all the other curves. Actually, the "standard" positions on the wave give at the extreme ends slightly smaller bending moments than some of the other positions; but the differences are so small, except in one case shown in Fig. 2, that they cannot be clearly shown on the diagrams. It is worth noting also that the "standard hogging" curve shown in Fig. 1 completely envelops the hogging curves obtained for the "standard sagging" condition of loading, shown in Fig. 2.

These results indicate that the "standard hogging" and "standard sagging" bending moment curves give, as well as the maximum values amidships, the maximum statical bending moments at all points along the length, unless at

* From a paper read at the spring meetings of the fifty-ninth session of the Institution of Naval Architects, London, March 22, 1918.

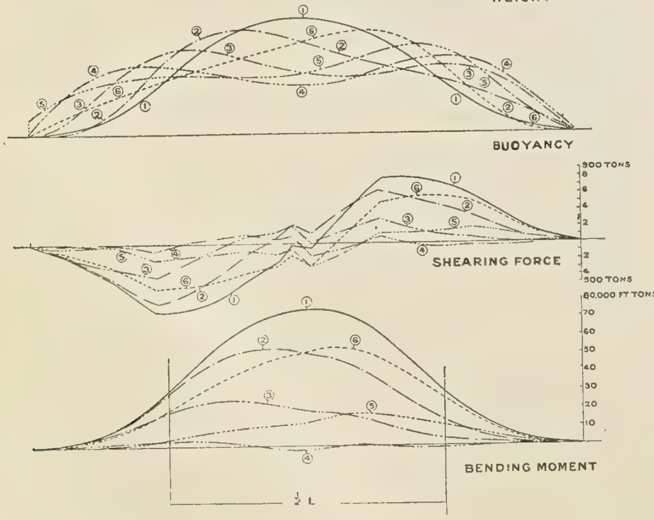


Fig. 1

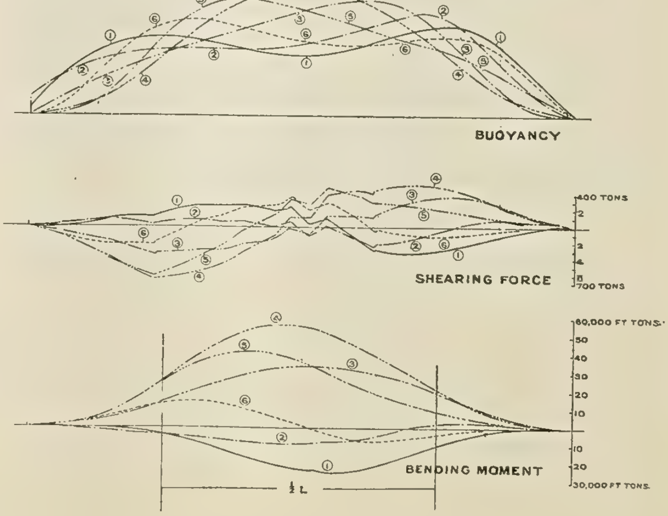


Fig. 2

the extreme ends, where, of course, the value of the bending moment is not of importance.

The Effect of Heaving

In the part of the investigation falling under the above heading, it is assumed that heaving motion can exist independently of pitching motion; in other words, it is assumed that a vessel can traverse a series of waves in such a manner that, while the displacement is continually varying, the centers of gravity and buoyancy are always in the same vertical line. The mathematical analysis of such a motion is given in an appendix. It is here necessary to consider the effect of the motion on the matter comprising the ship and her load.

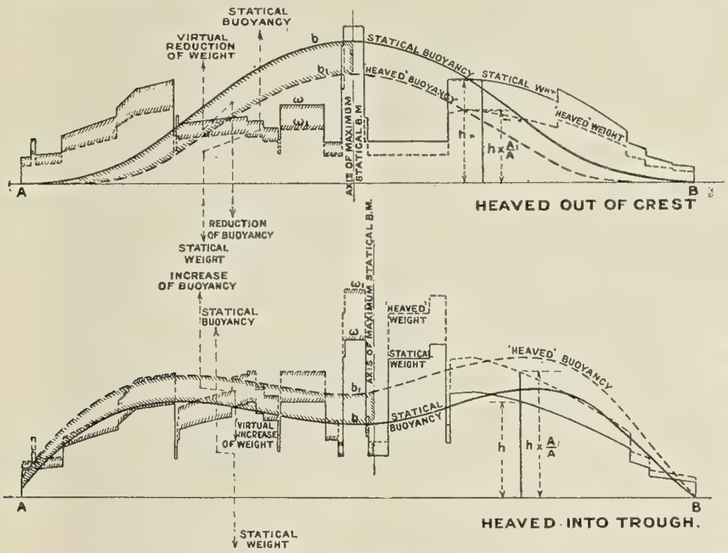


Fig 3

When a ship is heaving, the effect of the alternate upward and downward acceleration is that the "weight" is continually varying. When the acceleration is upwards, the "weight" is greater than, and when the acceleration is downwards the "weight" is less than, the normal amount when in statical equilibrium. For convenience, the "weight," when under the influence of heaving motion, is distinguished throughout as the "virtual weight." The upward acceleration, and so the "virtual weight," has a maximum value when the vessel is at her lowest position, heaved into a wave; the "virtual weight" is, then,

$$W + \frac{W}{g} \cdot \frac{d^2 y}{d t^2}, \text{ where } \frac{d^2 y}{d t^2}$$

is the amount of the maximum vertical acceleration. The corresponding buoyancy is $\Delta + P$, where P is the maximum excess buoyancy due to heave. Similarly, for the vessel heaved out of a wave,

$$\Delta - P = W - \frac{W}{g} \cdot \frac{d^2 y}{d t^2}.$$

The excess, or defect, of buoyancy is always equal to the excess, or defect, of "virtual weight" in relation to normal weight.

It follows that if the "heaved" buoyancy of a vessel is known, the corresponding "virtual weight" is known.

Since the "virtual weight" of a vessel when heaving is expressed by

$$W \pm \frac{W}{g} \cdot \frac{d^2 y}{d t^2},$$

the "virtual weight" of every element of the vessel is, likewise, expressed by

$$w \pm \frac{w}{g} \cdot \frac{d^2 y}{d t^2}.$$

The acceleration

$$\frac{d^2 y}{d t^2}$$

is the same for every element as for the complete vessel. Accordingly, the "virtual" correction at any point along the ship,

$$\frac{w}{g} \cdot \frac{d^2 y}{d t^2},$$

is proportional to the product of the element of weight and a constant quantity, the constant quantity being

$$\frac{w}{g} \cdot \frac{d^2 y}{d t^2}.$$

Hence it is possible to obtain a "virtual weight" curve by altering all the ordinates of a normal weight curve in a constant proportion. The extent of the alteration is governed by the condition that

$$\pm P = \pm \frac{W}{g} \cdot \frac{d^2 y}{d t^2};$$

in other words, the extent of the alteration is governed by the condition that the area under the "virtual weight" curve must be equal to the area under the "heaved" buoyancy curve. And so, having determined a "heaved" buoyancy curve, the corresponding "virtual weight" curve is obtained by proportioning the ordinates of the normal weight curve, so that the amended area, the area under the "virtual weight" curve, shall be equal to the area under the "heaved" buoyancy curve. For example, referring to Fig. 3, the area under the "heaved" buoyancy curve $A\ b,\ B$ is A_1; the area under the normal, or statical, weight curve $A\ w\ b$ is A. Each ordinate, such as h, of the statical weight curve is altered in the proportion

$$\frac{A_1}{A}, \text{ becoming } h \times \frac{A_1}{A}.$$

The area under the "virtual weight" curve $A\ w_1\ b$ so obtained is, then,

$$A \times \frac{A_1}{A}, \text{ or } A_1.$$

From the "virtual weight" and "heaved" buoyancy curves the "heaved" shearing force and bending moment curves are obtained by integration in the ordinary manner.

As regards extent of heaving motion, it was shown by Mr. T. C. Read that for a vessel on the crest of a wave the only possible heave of any magnitude is a heave *out* of the wave; for a vessel across the trough of a wave the only possible heave of any magnitude is a heave *into* the wave. As regards the effect on the bending moment, the effect of the heave with the consequent alteration of buoyancy and "virtual weight" is that an additional bending couple is brought into action; when the vessel is heaved out of a wave the buoyancy and "virtual weight" are less than normal, and the additional bending couple acts in opposition to the statical couple, so that the bending moment, including heaving effect, is less than the statical moment; when the vessel is heaved into a wave and the buoyancy and "virtual weight" are greater than normal, the additional bending couple acts in conjunction with the statical couple, so that the bending moment, including heaving effect, is greater than the statical moment (see Fig. 3).

(To be continued.)

Electric Propelling Machinery for the Battleship Tennessee

WHILE electric propulsion gives approximately the same overall economy in steam consumption as a geared turbine drive, nevertheless it offers an added advantage of greater latitude in the location of the propelling machinery, a feature which is of greatest importance in the design of naval vessels. The United States Navy has taken the lead in the application of electric drive to battleships and battle cruisers; and of the recent installations, that of the battleship *Tennessee* is of special interest, as it involves certain features which have been developed as a result of previous installations of electric propelling machinery in vessels of this class. The principal details of the installation on the *Tennessee* were described by Wilfred Sykes, general engineer for the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., in a recent issue of *The Electric Journal,* from which the following information is taken:

The *Tennessee* will be one of the most powerful fighting ships built, having displacement of over 32,000 tons and a speed of 21 knots at full power. The equipment for propelling the ship will consist of four 3-phase induction motors, each driving one propeller, and two turbo generators for supplying the motors with power.

Each of the four motors will develop 7,000 horsepower at a speed of about 180 revolutions per minute, and will be capable of working continuously at 8,375 horsepower as an overload condition. The motors have two windings of 24 and 36 poles, so that they have two normal speeds of 123 and 180 revolutions per minute with full speed of the turbine. In this way it is possible to run the turbine at its most economical speed when steaming either at full power or cruising at 15 knots. Intermediate speeds are obtained by varying the speed of the turbine, and the equipment is designed to maintain a low water rate over the full range of speed from ten knots up. When operating below 17 knots, only one generator is used, and this improves the economy, as the load on the unit is brought nearer to its full capacity.

Two-Pole Generators

The turbo generators supplying power to the main units each develop 13,500 k. v. a. at full speed and are capable of carrying 15,000 k. v. a. continuously for the overload conditions. The generators are two-pole machines and the unit runs at 2,190 revolutions, corresponding to 36.5 cycles per second, with the motors running at 180 revolutions per minute. The maximum speed of the turbo generator is 2,270 revolutions per minute, corresponding to 37.9 cycles, equivalent to a motor speed of 186.5 revolutions per minute, which requires 8,375 horsepower. To obtain lower speeds, the turbine speed is reduced to about 1,500 revolutions per minute, which corresponds to the change-over point from the 24- to 36-pole connection of the motors.

With the change-over of the motor connections, the speed of the generator is increased to 2,270 revolutions, corresponding to 15 knots with the 36-pole connection. The motor speed combination is simply the equivalent of a variable ratio of gearing, which, in the case of the 24-pole connection, is 12:1, and with the 36-pole connection 18:1.

The direction of rotation of the machines is controlled by reversing switches which simply transpose two of the phases at the motors, the generator, of course, continuing to run in the same direction.

The motors have two separate windings on the stator, one the 24-pole and the other the 36-pole connection. The same results might have been obtained by use of one winding, but this would have entailed greater complication in the connections and would have restricted the design in other ways.

The rotor has a single polar winding for 24 poles, which is connected to the slip rings in the ordinary way, so that resistance can be inserted in the circuit during starting or reversing. When the machine is operating on the 36-pole connection the rotor winding cross-connections act as short-circuiting connections for this pole combination. With the 24-pole combination, they act as equalizing connections between points of equal potential. On the 36-pole connection the motor operates as a squirrel cage machine, and it is not intended that this winding should be used during the starting or reversing, but only as a running winding. In this way only one winding is used and one set of slip rings.

The Turbine Governor

The speed of the turbine is varied by means of a unique hydraulically operated governor. The loading of the governor is regulated by means of a variable pressure oil system, the pressure of which is regulated with great accuracy by a pressure regulating mechanism operated by the control handle. In this way any mechanical connection through shafts or rods with the governor from the operating point, with the consequent danger of jamming where passing bulkheads, is avoided. A unique feature of this arrangement is that the pressure is caused to pulsate slightly so that the whole of the regulating and governor mechanism is kept slightly in motion, and thereby prevented from sticking, also adding greatly to the sensitiveness of the control, which is of great importance when ships are steaming in formation.

The turbines are of the Westinghouse semi-double flow, impulse-reaction type. The high pressure steam is expanded in suitable nozzles and passes through a two row impulse wheel, after which it passes through the first stage of the reaction expansion, which is single flow. The steam then divides and passes through the low pressure stages of the turbine, which are double flow. The turbine is provided with an automatic stop to cut off steam in case the speed should exceed the maximum safe operating value. The main hydraulically operated governor maintains speed practically constant at any value set by the control mechanism, independent of the load, so that in case the propellers should leave the water during rough weather there will be no racing.

Insulation

The generators and motors are very carefully insulated for this service, so as to prevent damage due to moisture or the accumulation of salt, and also due to the high temperatures which are liable to be encountered in this service. The principal material used for insulation of coils in the slots is mica, and the machines are capable of withstanding slot temperatures up to at least 150 degrees C. without injury. Ventilation of the generators is provided by fans supplying air to each engine room and the fans on the generator forcing the air through the machine and out through ducts. The motors each have two fans mounted directly above them which draw the air through the motor and force it out through the ventilating ducts. The generators are excited from the direct-current power circuit of the ship through boosters which are capable of raising the normal 240-volt supply to 320 volts or reducing it to zero.

The power supply from the turbo generators is brought to a centrally located control room in which is mounted all the necessary switching apparatus for controlling and distributing the power to the motors. In this room is mounted the regulating apparatus for the main turbines, the field switch and rheostat for the turbo generator excitation, and the liquid rheostats for the main motors. All necessary instruments for the operation of the equipment are mounted directly in front of the operators and full advantage is taken of the great facility with which electric power can be measured, inasmuch as it will assist in the operation of the ship.

Automatic Liquid Rheostats

For starting and reversing the main motors, automatic liquid rheostats are used which are of a similar design to those used previously for industrial purposes. These liquid rheostats consist of two tanks, the upper containing a series of fixed electrodes and the lower acting as a reservoir. By means of a suitable pump, the electrolyte is caused to flow from the lower to the upper tank at the proper rate to cause the desired acceleration. When the by-pass between the two tanks is open the electrolyte is maintained within the electrode tank at the proper level to give the maximum resistance. When this by-pass is closed the electrolyte rises in the upper tank, thereby progressively short-circuiting the electrodes until the minimum resistance is reached at the overflow point, after which the liquid simply continues to circulate through the two tanks. A switch is provided so that this rheostat may be short-circuited.

The cables for connecting the turbo generators and motors are of great importance, as the operation of the ship depends upon their reliability. A number of parallel circuits are used, each cable being of the three-core type, and the failure of any single cable would not seriously interfere with the operation of the ship. The main cables are of the same order of importance as the main steam pipes; hence the greatest care has been taken to insure that these cables should be the best type that is possible to manufacture for the service, and to this end a committee of the American Institute of Electrical Engineers assisted the Navy Department in preparing the specifications.

Engine Room Auxiliaries

The main auxiliaries in the engine room are electrically driven. The main circulating pumps are driven by 235-horsepower, direct-current motors, directly connected to centrifugal pumps, the speed of which can be varied to suit various conditions of operation. In this way the power consumption can be reduced as the speed of the ship is reduced. The principal provision for maintaining vacuum in the condenser is the use of LeBlanc air ejectors, which are novel for this class of ship. These air ejectors have already been successfully tried out by the Navy Department on other vessels with such satisfactory results as to justify their adoption for these vessels. The condensate from the condensers is handled by vertical electrically driven centrifugal condensate pumps, so that the whole of the essential auxiliary apparatus for the turbines is rotary, and, based on the experience in land service as well as at sea, a greater reliability and lower maintenance can be anticipated for these equipments compared with past practice. The use of air ejectors enables the vacuum to be maintained at least as high, if not higher, than the older combination of reciprocating air pump and Parsons augmentor, and the space and weight are a very small fraction of that required with the older system.

While steam consumption is not of vital importance, on account of the other advantages of electric drive, yet the figures that can be obtained are very appreciably better than the direct-connected turbine and are lower than any past practice. From 10 to 15 knots, only one generator is used, the motors being connected for 36 poles. From 15 to 17 knots, the motors are connected for 24 poles and one generator is used. From 17 knots to 21 knots, both generators are in operation, each machine supplying power to two motors, each side of the ship being independently operated.

In designing the equipment for the *Tennessee*, every effort has been made to avoid the introduction of experimental or risky constructions, and the design is such that the experience gained in other fields has been utilized to full advantage, and the design factors have been kept within well-developed practice. At the same time, provisions have been made so that the full advantages of the characteristics of electric drive can be utilized in the operation of the ship.

What Italy Is Doing With a Big Inland Waterway Plan

Among the progressive things that Italy has been doing in the past dozen years in line with an advance of industry is the beginning that was made upon a system of barge canals in Lombardy, which will eventually give navigation for 600-ton vessels for fully 300 miles into the interior from the Adriatic and tap even the lake region of Southeastern Switzerland.

With about 25 miles already finished, the map calls for 250 miles of "naviglio" along the Po and Adda rivers, with a cut across to Milan some 30 miles long. According to an account of this enterprise given in a recent issue of *The Americas*, it is not only a heavy barge trunk line that is projected, but many spurs will lead off on either side to bring into the waterway system the slow traffic transportation of about a dozen cities of Lombardy that lie between Milan and Venice.

The harbor of Venice has already had attention as part of the scheme, so that the barge traffic will there connect with ships. Further inland, smaller canals extend the benefit of the new transportation to Lake Como and to Lake Maggiore. The ultimate development contemplates a system of inland waterways focusing upon the Lagoon of Venice, with an aggregate length of about 2,000 miles.

It is a government enterprise, to be carried on and financed in co-operation with the various cities that will be benefited, the government bearing three-fifths of the cost, the localities the remaining two-fifths. A new industrial port, with modern harbor improvements, will be developed at Venice. When the full plan of canalization is completed the Po will be navigable by vessels of 600 tons up to Cremona. After canalization of the Adda, which flows down from the Milan country into the Po, near Cremona, the main canal will be dug across the dry land to Milan.

The purpose of the new waterway system is to make possible the inexpensive movement of heavy raw materials needed by local industries, and thus divide traffic with the rails. The rails at this time being badly overworked, such a division would greatly enhance shipping facilities. An important feature of the system will be the up-to-date river terminals established at the inland centers.

Can anyone tell why small spring wire deteriorates in sunlight and becomes brittle?

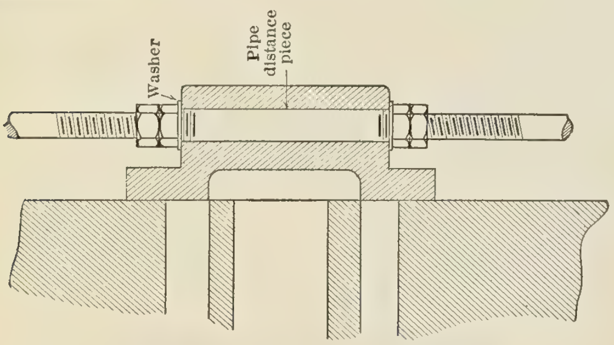
Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Curious Displacement of Slide Valve

A very curious incident occurred to the writer about three years ago. He was on one of the company's tug boats, which had a two-crank, quadruple engine, with the cylinders arranged as follows: High pressure and first intermediate pressure cylinders on stanchions 2 feet above the second intermediate and low pressure cylinders. The high pressure was over the second intermediate and the first intermediate over the low pressure cylinder. While under way, the engine gradually began to slow down, until finally it began to make revolutions with jerks, going very slowly. Luckily, a few minutes' steaming put us in a safe anchorage.



Sketch Showing Valve and Spindle

At first an examination revealed nothing unusual. The second intermediate pressure slide valve was tried and appeared all right, the nuts at top and bottom being perfectly tight. At length we put the second intermediate pressure crank on the top center and discovered the trouble—the lead on top was 1¼ inches. The valve had two nuts on top on the spindle and two nuts underneath on the spindle, yet these nuts were jammed perfectly tight and the valve had only breathing space to keep it on the face. If the valve had dropped as much as it showed by the lead, why was it that all the nuts and the valve seemed all right? Nothing was slack and the thread on the spindle was not stripped.

On slacking off the two top nuts to enable us to raise the valve to the required lead we discovered a pipe distance piece on the spindle. This, of course, passed through the spindle hole in the back of the valve. With the top nut underneath the valve and the bottom nut on top of the valve, both tightened on this pipe distance piece, and the other two nuts acting as jam nuts and the whole tightened up, just left breathing space for the valve to seat, and did not jam the valve. Therefore, it will be seen that the nuts and pipe were practically one long nut and had gradually screwed down the rod. The nuts, when separated, were slack on the rod, and the mere fact of checking the nuts had not arrested the slackness.

Engineers will agree that a pipe distance piece is not a desirable thing to have through a slide valve, unless the valve sits on a collar on the rod, with only two nuts on top of the valve to check it.

Victoria, B. C. EDMUND B. DELL.

Packing Troubles*

In talking to a chief engineer not long ago, I showed him a picture of a metallic packing which is giving very good service all over the United States and Canada. A point in its favor is that it needn't be removed very often, if at all. An installation was inspected lately where a plunger equipped with this packing had been in operation for six years, operating against 160 pounds of pressure, 212 degrees water, operating 12 hours per day. The plunger was not so much as worn 1/1000 inch. The packing was still in perfect condition and looked as though it would last twelve years more. The engineer in charge thought that the packing had saved him considerable time and labor, and the owner considerable money.

The chief engineer to whom I was talking, however, had his mind already made up. He was not open to conviction. He said, "I have tried metallic packing and will never try it again. In time it becomes a solid metallic mass, and, if used in places that are accessible with difficulty, it cannot be removed easily enough. I have had to chip it out in several instances."

It is regretable that such chiefs still exist. He is in charge of a large plant, and his mind should be open to new things. Improvements or attempts at improvements should be looked upon in an unbiased way, regardless of what experience may have taught with other equipment made of the same material. If all engineers had thrown up their hands after the first failure, we would not have progressed very far in the manufacturing world. With any packing, whether it be fabric or metallic, there are some cases where inaccessibility in design of stuffing boxes makes the packing very hard to remove. And the engineer's statement with reference to the metallic packing is true to the extent that it is more difficult to remove than the fabric, though it is the claim of this manufacturer that his packing needn't be removed. In other words, if you get the right packing you can leave it in, and removal troubles are eliminated. In case it is necessary to remove such metallic packing as are made of babbitt foil, spirally wound, it is not very difficult to screw into the packing itself with packing hooks made for the purpose and pull the packing out. With separate individual rings, which do not amalgamate with the other rings because of the laminated construction and lubricant between every sheet, the removal operation is performed with still greater ease.

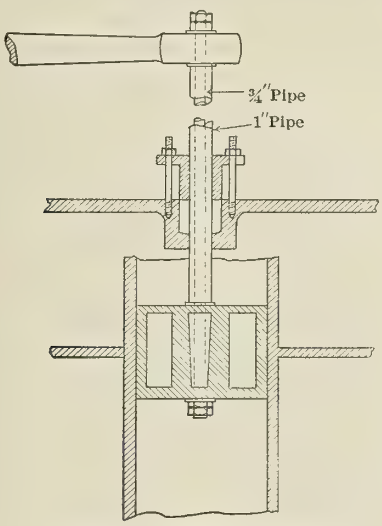
So, all in all, the writer is convinced that the above chief engineer is considerably in the wrong. His case is analogous with that of the engineer who declared he would never install another centrifugal pump because he "tried one once" and it wouldn't pump enough water. The pump he had was all right for its capacity, but what the engineer needed was a larger capacity pump. However, the engineer couldn't "see it that way," because he had been prejudiced against "newfangled" equipment from the start and was determined to go back to the old form

of reciprocating pump, which was a steam waster, though he could speed it up when he wanted to pump a greater volume of water in a given time. W. F. Schaphorst.

Broken Circulating Pump Rod

The following account of a breakdown, namely, a broken circulating pump rod, and of the quick and efficient work of repairing that was made, may prove interesting and worthy of note to engineers—those who happen to be on small boats especially. Although the breakdown occurred on a small boat, the modus operandi could be applied also on fairly large steamers.

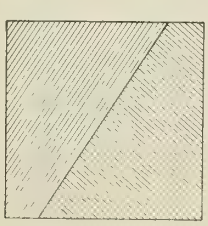
The circulating pump in question was driven off the pump levers (a plunger pump), with bilge and feed pump plungers at one end, air pump in the center, and circulating pump on the other end. When under way, the circulating pump rod broke in the middle. Having no spare rod on the ship, a speedy repair was made in the following manner:



Sketch of Broken Pump Rod

The rod was 1⅜-inch diameter and carried a solid brass bucket. A piece of ¾-inch screwed iron pipe was cut off the exact length of the rod, and, after screwing both ends, two check nuts were fitted on each end.

The length of the rod from the top of the bucket to the under side of the crosshead was made up by a distance piece of 1-inch pipe. By a little filing, the length of ¾-inch pipe was passed right through the bucket, the 1-inch distance pipe and the crosshead being secured by a washer with check nuts on top of the crosshead and two check nuts under the bucket. The 1-inch pipe, or distance piece, taking the place of the solid rod was filed up



Section of Packing

smooth to work through the packing in the gland. As this pipe was a trifle smaller in diameter than the solid rod, the gland was packed with square tucks packing cut, as shown in the sketch, which, when squeezed up by the gland, made it perfectly tight.

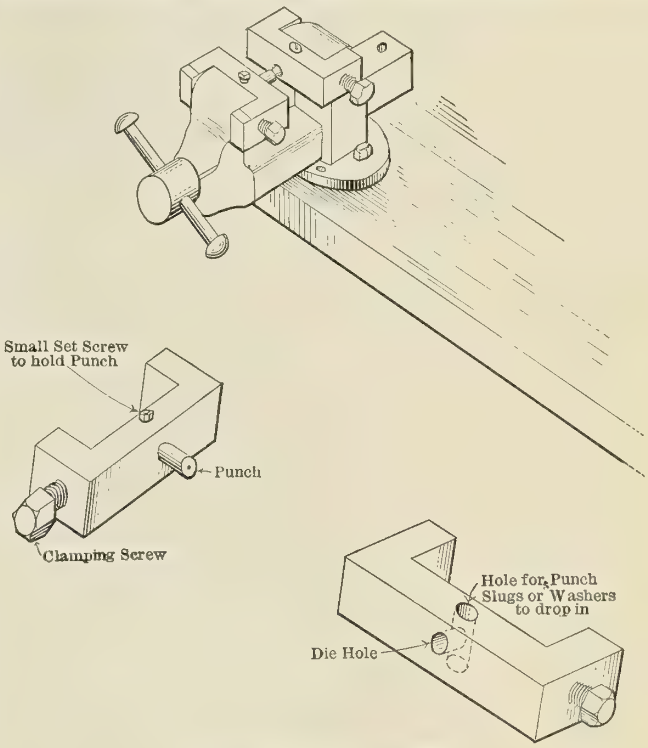
The pump did yeoman service for several days until a new rod was fitted. A glance at the section of packing will at once reveal the action of the packing in taking up the 1/16-inch slackness between the stuffing box and the rod.

A tug boat on this coast became a total wreck through her circulating pump rod breaking when making port in a heavy sea. When only half a mile from the entrance of the harbor, and, being disabled, she got in the trough of the sea before any repairs could be made and was washed ashore on the rocks, where she pounded herself to pieces.

Victoria, B. C. Edmund B. Dell.

Vise Punch Rig

For punching thin sheet metal, a handy little rig such as is shown in the sketches will do the work very well. It consists of two U-shaped pieces of stock fitted with common set screws for clamping them to the bench vise



Handy Vise Punching Rig

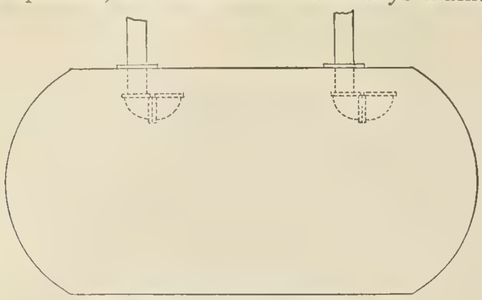
jaws, as shown. Anyone handy with tools can make up a set in spare time, and when one considers what mean work drilling thin stock is the value of a punch like this can easily be seen. C. H. Willey.

Curing Trouble from Noisy Return Lines

We had in service a large cylindrical tank into which discharged a number of drain lines from heating coils and straps. These originally were arranged to discharge flush into the tank, as shown in solid lines. However, in some conditions it was found that when returns were not coming back from one pipe while hot returns and steam were being discharged from others, the steam had a tendency to back up in the empty return pipes until a slug of cooler water was encountered coming back, when frequently a pronounced water hammer resulted.

In order to eliminate this trouble we decided that it would be necessary to install U seals in the various return lines, but before doing this we hit upon the scheme of water-sealing the outlets, as shown on sketch, merely by

the use of a long nipple and two elbows with the discharge pointed upwards, so that there was always maintained a



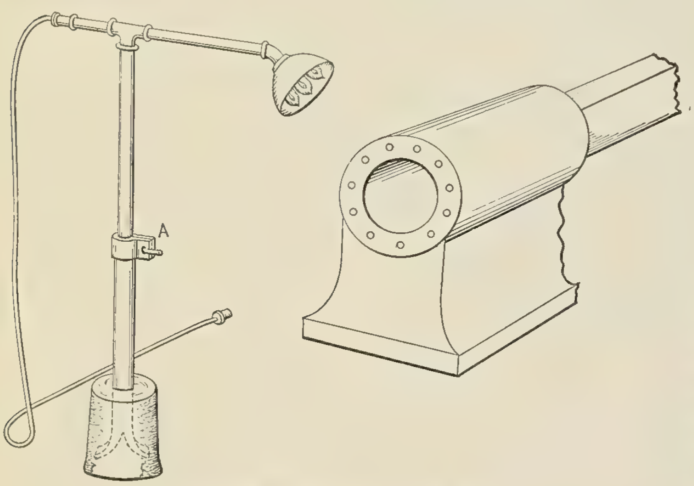
Water-Sealed Outlets

water seal at the ends of the return lines. The thing worked out all right.

Philadelphia, Pa. W. A. Lailer.

Portable Floor Light Stand

This stand will be found very useful for holding a floor light cluster. It is adjustable to any desired height and is very simple to construct, being almost entirely made from old worn-out pipe and fittings and a little cement or concrete.



Sketch Showing Light on Job

The end of the lower pipe is split and spread open to act as anchors in the concrete. The upper section of pipe telescopes into the lower.

A bit of flat stock is made into a clamp for use at A; it clamps the upper pipe tightly, and this clamp sets on the upper end of the lower pipe.

Concord, N. H. C. H. Willey.

Three Kinks That Have Proven Successful

I am sending you in this letter a few sketches which have proven to be successful and economical through their installations.

No. 1 represents a grease gun easily made by any engineer. The gun consists of a 3 by 12-inch pipe having a smooth bore, two pipe caps, a 14 by ¾-inch feed screw, handwheel and piston; also two grease cap filler pipes, as shown in sketch.

No. 2 represents a truss collar or ring which was made and installed between a large rotating boiler journal bearing to take up end thrust. As the journal bearing end shoulder was worn off ⅛ inch, allowing the boiler drum to run against the frame, the weight of the boiler being about 5 tons, it would have been very difficult to place a solid ring between bearings.

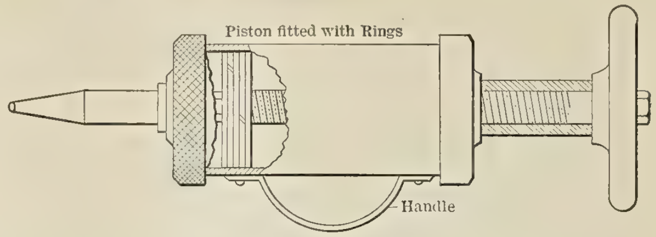


Fig. 1.—Grease Gun

The ring was made of brass 3/16 inch by 14 inches by 8 inches bore split through center, drilled and slotted, as shown. After placing the ring in position it was soldered together in the joints, which were counterbored and beveled.

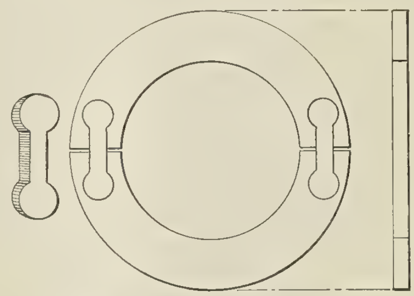


Fig. 2.—Truss Collar or Ring

No. 3 represents a gate valve and water release connection. Before the installation of the water release or drain valve and piping, trouble was always sure to develop when the gate valve on the main engine steam header line was opened, on account of the water having accumulated in the line. This resulted in causing the explosion of the boiler gate valve, releasing the steam from two 400-horsepower boilers at 165 pounds pressure. Since installing this improvement, no more trouble has been experienced.

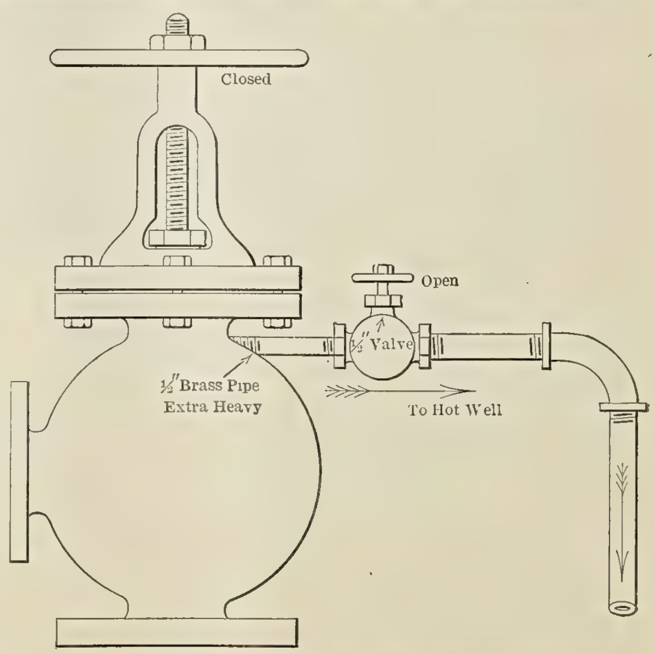


Fig. 3.—Gate Valve and Water Releasing Connection

The gage valve is first drilled with a 23/32-inch drill for a ½-inch pipe tap, 1¾ inches below top flange. A ½-inch by 4¼-inch extra heavy brass nipple is screwed onto a full thread and a ½-inch brass globe valve is attached to nipple. Connection from globe valve is made to the hot water well or feed water tank.

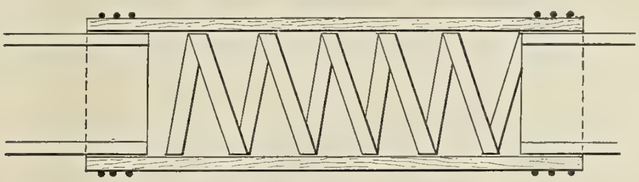
Operation

In operating this improvement, one valve is always closed and one open, so that when the gate valve is open the water release valve remains closed. When the gate valve is to be opened it is given a slow turn, allowing the live steam to expel any and all water from line and valve. The water release must be tightly shut when the gate valve is opened.

Stillwater, Minn. Otto Dorthen.

Hose Kink for Suction Lines

On board ship it is often very desirable to use hose on the various suction lines because of the flexibility offered, etc. The writer had one experience in connection with a 4-inch water suction line. A flexible joint was necessary and a piece of light rubber and canvas hose was inserted between the two pipe ends, but when the pump started sucking, the walls of the hose were so thin that they could not withstand the air pressure from without and the walls collapsed.



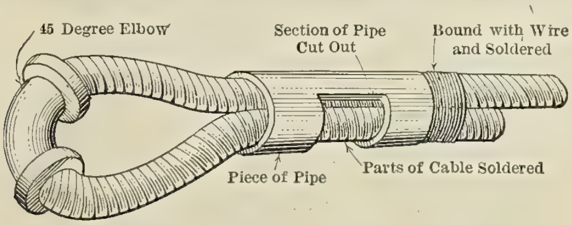
Spring Distender for Hose

To prevent these we took a stout piece of wire, bent it in the form of a spring to fit the inside of the hose, as shown in the sketch, and fastened it there. This wire support served nicely to hold out the walls of the hose while under suction pressure. The same arrangement can doubtless be used by other engineers who are forced to use poor grades of hose or light hose on suction lines.

Philadelphia, Pa. W. A. Lailer.

Cable Eye Kink

Sometimes there is need to put an eye in a hoist cable or sling, and no time is available to put in a splice, or perhaps no one at hand knows how to do it successfully. The



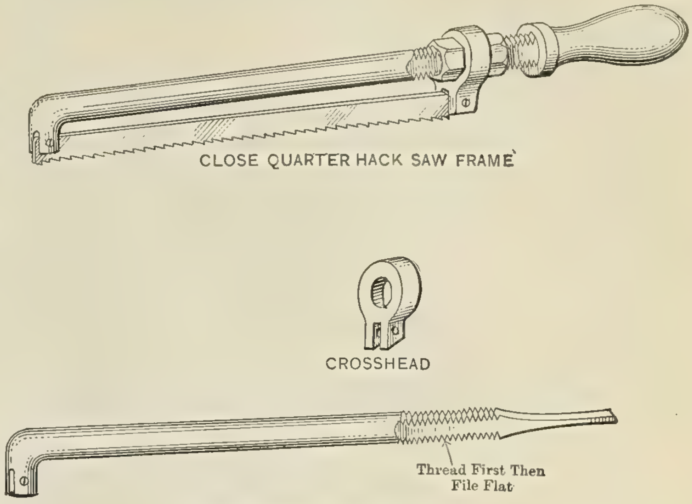
Splicing Emergency Eye for Use in Cable

idea shown in the sketch will be found very handy to such fellows and it may be worth adding to their note books.

Splicer.

Close Quarter Saw

Often there is need to use a hack saw in very close quarters, and to meet this need this home-made frame was made. Its construction is very simple. The material needed is but a short length of ⅜-inch round rod and a



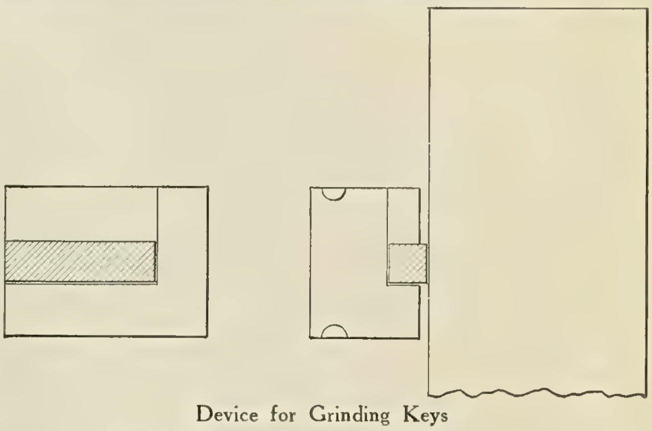
Details of Close Quarter Saw

bit of flat stock with which to make the crosshead. One end of the rod is bent short at right angles and a slot cut to take the blade. The other end is threaded for a few inches and then two sides are filed flat to take the cross head and the file handle. Further details are given in the sketch.

C. H. Willey.

Facilitating the Grinding Down of Steel Keys

The engineer is frequently called upon to grind down to size keys for attaching flywheels, pulleys and pinions to



Device for Grinding Keys

a shaft. Where this work is attempted on a grindstone it is possible to secure a bad burn from the overheated metal and to secure an unevenly ground surface unless a proper device is used to hold the key. One of the most satisfactory methods is to take a small block of wood about 4 inches long by 2 inches wide and 2 inches deep and cut out one corner, as shown in above sketch, into which the key can be placed and rigidly held against the stone without fear of being burned by the heat generated and with the assurance that a fairly even finish will be obtained because of the even surface against which the piece of metal is held.

Machinist.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY H. A. EVERETT

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number if from examination for grade of chief, and by a dagger (†) if from examination for other grades.

Sag of Wire in 200-Foot Span

Q. (980).—I have a line to run of about 200-foot span. Can you give me the sag of the wire or a method of computing it?

A. (980).—If you use a No. 27 gage steel piano wire attached to a fixed point at one end, and at the other passing over a roller and loaded with a weight of 52 pounds, the sag at 10-foot intervals, as experimentally determined, is as follows:

Distance		*Sag*
10 feet and	190	11/64 inches
20	180	21/64
30	170	29/64
40	160	37/64
50	150	11/16
60	140	49/64
70	130	53/64
80	120	7/8
90	110	29/32
100		29/32

Formula for Computing Size of Main Steam Pipe

Q. (973).—What is the formula for computing the size of the main steam pipe from the boilers to a Parsons steam turbine?

A. (973).—Seaton gives the following, which is based on an allowed steam speed through the pipe of 8,100 feet per minute:

$$\text{Diameter (ins.)} = \cfrac{\text{Diameter of high-pressure cylinder (ins.)}}{\cfrac{90}{\sqrt{\text{Piston speed (feet per minute)}}}}$$

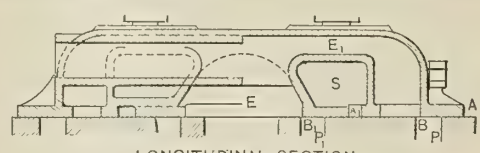
Present practice in turbine installations is to accept a lower allowable steam speed of about 4,500 to 6,500 feet per minute, as it was found that there was considerable loss of pressure from boiler to throttle with the higher speeds. The lower velocity should be used with small pipes.

Double Ported Slide Valve

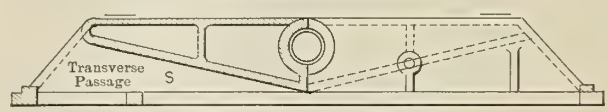
Q.* (976).—What is a double ported slide valve and the reason for using this style of valve?

A. (976).—In a reciprocating engine of large power, therefore requiring a large amount of steam, the necessity of providing large passages for the free flow of this steam into and out of the low pressure cylinder, requires some modification of the ordinary type of *D* slide valve. If the slide valve type is retained, the additional area of steam passages required may be provided for by doubling the travel of the normal D type of slide valve and widening out the ports of the cylinder or by keeping the travel the same and providing an additional set of ports governed by another valve made an integral part of the D valve. This latter is the usual solution and results in the double ported slide valve, which is really nothing more than a large slide valve of the D type, straddling a smaller one, each operating over its own admission ports and with the exhaust entering a common chamber and discharging through the regular exhaust passages, as can be seen in Fig. 1.

Steam surrounds the outside of the valve and enters port *P*, going by edge *A*, when the valve is displaced to



LONGITUDINAL SECTION



CROSS SECTION AND END VIEW

the left. The passage *S* connects directly to the steam space so at the same time admission occurs in the port P_1 past the edge A_1. When the valve is displaced to the right, as shown, exhaust occurs from both *P* and P_1 to *E* and E_1, which unite, as shown, and deliver to the common exhaust.

Slip

Q.* (977).—Propeller is 12 feet pitch; engine making 100 revolutions per minute; ship making 10 knots. What is the slip?

A. (977).—

$$S = \text{slip (expressed as a decimal)} = \frac{PR - V}{PR}$$

When P = pitch of propeller in feet
R = revolutions per minute
V = speed in feet per minute

$$S = \frac{12 \times 100 - \dfrac{10 \times 6{,}080}{60}}{12 \times 100} = \frac{1{,}200 - 1{,}013}{1{,}200}$$

$$= .156 = 15.6 \text{ percent.}$$

If V is expressed in knots, $S = \dfrac{PR - 101.3\,V}{PR}$.

Rule for Tonnage of Ship

Q. (978).—Can you give me an approximate rule for the determination of tonnage of a ship from her principal dimensions?

A. (978).—The following expressions will give reasonalby close estimates of gross tonnage for normal types freight and intermediate steamers. They are the result of curves drawn in my office, using the data from a large number of ships, and have not been published heretofore:

Three Deck Type

$$\text{Approximate gross tonnage} = \frac{0.79 L \times B \times D + 5 l \times B}{100}$$

L = length between perpendiculars,
B = molded beam.
D = depth from top of tank to upper deck at side,
l = combined length of bridge, poop and forecastle.

Shelter Deck Type

$$\text{Approximate gross tonnage} = \frac{0.86 L \times B \times D + 5 l \times B}{100}$$

L = length between perpendiculars,
B = molded beam.
* D = depth from top of tank to upper deck at side,
l = combined length of bridge, poop and forecastle.

* Upper deck is deck below shelter deck.

Marine Technical Publications

Q. (982).—Please give a list of the principal marine technical publications?

A. (982).—Some of the major publications are given below:

Marine Engineering, monthly, Aldrich Publishing Company., New York City, $2.00 per annum.

Journal of the American Society of Marine Draftsmen, quarterly, Washington, D. C., $1.00 per annum.

Journal of the American Society of Naval Engineers, quarterly, Navy Department, Washington, D. C., $5.00 per annum.

Marine Journal, weekly, 17 State Street, New York City, $2.00 per annum.

Marine Review, monthly, Penton Publishing Company, Cleveland, Ohio, $2.00 per annum.

United States Naval Institute Proceedings, Naval Academy, Annapolis, Maryland, bi-monthly, $3.00 per annum.

Transactions of the Society of Naval Architects and Marine Engineers, annually, 29 West 39th Street, New York City, $10.00 per annum.

Transactions of the Institute of Engineers and Shipbuilders in Scotland, issued irregularly, Glasgow, Scotland.

Transactions of the North East Coast Institution of Engineers and Shipbuilders, monthly, Newcastle-upon-Tyne.

Shipbuilding & Shipping Record, weekly, London, S. W. I., £1, 12s.

Engineering (London), weekly, 35 Bedford Street, Strand, London, W. C., £2, 9s, 6d.

Motor Ship and Motor Boat, weekly, 7-15 Rosebery Ave., London, E. C., 17s, 4d.

NEW BOOKS

The Submarine in War and Peace: Its Development and Possibilities. By Simon Lake, M.I.N.A. Pages, 9 by 5½ inches. Illustrations, 71, including a chart. Philadelphia, 1918: J. B. Lippincott & Company. Price, $3 net.

Simon Lake, the inventor of the Lake submarine, which has played such a great part in the war in the navies of the world, has given in this book a guide for those who wish to know more of the submarine, its mechanism and possibilities. The romance of submarine inventions is a tale well worth telling, and in describing the evolution of the submarine Mr. Lake has set forth lucidly the wisdom gained from many years' experience of successful submarine invention.

To-day the submarine is a factor in the political and industrial life of the world, carrying possibilities of the most astonishing nature. Among the many wonders which the war has brought vividly to our attention, no other, save the aeroplane, is so full of romantic interest as the submarine. Between them, these two agencies are likely to revolutionize the life of the world in many ways. Chapter VI, which discusses the possibility of defeating the submarine, will be read with the keenest attention. No one is better fitted to discuss this subject than this greatest of marine engineers.

Previous to its publication in book form, much of the material contained therein appeared in the columns of Marine Engineering.

The author shows that as a commercial carrier, in hydrographic work, scientific exploration, navigation under ice fields, etc., the industrial possibilities of the submarine are of great moment and that the submarine is destined to protect the weak and serve humanity in general in many ways. The book is generously illustrated and readable from beginning to end.

Rust's Practical Tables for Navigators and Aviators. By Captain Armistead Rust, U. S. Navy. Philadelphia, 1918: John E. Hand Sons Company. Price, $3.50.

In this small volume, published by members of the United States Naval Reserve Force in the Fourth Naval District for the benefit of those who aspire to a commission, are contained new tables and diagrams that afford short cuts for performing the necessary calculations in working traverse problems, plane sailing, correction of observed altitudes, dip table for aviators, ex-meridian altitude tables, the time at sea, Sumner lines, the Marcq Saint-Hilaire method, identification of stars, great circle course and distance, finding the azimuth of any body.

Every aspirant for a commission in the naval service or for an officer's position in the merchant marine, as well as every captain and navigator afloat, will find this book of valuable assistance in his work. All problems in practical navigation may be solved by it, and in most cases many pages of Bowditch, etc., are reduced to a single diagram or to a page or two of the new tables.

Maximum Base Prices, Differentials and Extras on Iron, Steel and Non-Ferrous Products. Size, 6 by 8¼ inches. Pages, 78. Charts, 3. Cleveland, 1918: The Penton Publishing Company. Price, $1.

This booklet gives complete schedules of maximum prices on iron, steel and non-ferrous products as fixed by the Government which are now in effect. Owing to the numerous changes during the past six months, which have rendered practically obsolete similar lists previously issued, this up-to-date price manual will be found especially useful.

Practical Design of Marine Single-Ended and Double-Ended Boilers. By John Gray. Size, 5 by 7¼ inches. Pages, 84. Illustrations, 21. Plates, 4. New York, 1918: D. Van Nostrand Company. Price, $1.25.

This book is intended as a guide to draftsmen and engineers who are already familiar with similar types of boilers, but lack the experience necessary to design large single- or double-ended boilers. In it will be found illustrations and a complete description of the detailed design of 3 and 4-furnace single-ended and double-ended Scotch boilers and also the Inglis patent boiler.

A worsted tassel oiler on a horizontal piston rod is a most satisfactory rig. If you have never seen one ask about it. It will come in handy sometime, perhaps, to know about it.

Shipbuilding and General Marine News

Contracts for New Ships—Shipyard Improvements—Engineering Projects—Improved Appliances—Personal Items

NEW SHIPYARDS AND EXTENSIONS OF EXISTING YARDS

Additions, Improvements, and Orders for New Equipment

The Pacific Shipbuilding & Terminal Company has been incorporated in California to operate a yard in the vicinity of Long Beach. Among the incorporators are Malcolm H. Murray and W. Frank Fisher, of Los Angeles.

The Emergency Fleet Corporation has authorized the construction of twelve new shipways at the yards of the Pusey & Jones Company, Gloucester City, N. J.

The Cholberg Ship Company will build a yard at Victoria, B. C., where it will construct wooden vessels.

The Jacksonville Dry Docks & Repair Company has been incorporated, with headquarters at Jacksonville, Fla. The incorporators are E. F. Terry, J. W. Hollister and S. L. Walker, all of Jacksonville. These men have also incorporated the Brittain Shipbuilding Company, to build steel vessels.

The United States Shipping Board is planning the construction of a dry dock at San Pedro Harbor, Los Angeles, Cal.

The Greenport Ship Company has purchased the property of the Radel Oyster Company, Greenport, L. I., and is planning to build steel trawlers and to repair fishing craft.

Announcement has been made by the United States Shipping Board that a 10,000-ton dry dock and repair plant will be built at New Orleans.

The North River Ship & Engineer Corporation has been organized to operate a shipyard. The incorporators are M. Metkiff, E. P. Schonburg and P. D. Denison, 154 Nassau street, New York.

The West Seattle Boat & Engine Company has been incorporated by H. H. Guth and H. A. Bernardo, Seattle, Wash.

The Downing Marine Construction Company, 17 Battery Place, New York, has plans for a yard at Sea Cliff, L. I., where it will build steel barges for use on the New York State Barge Canal. The company already has an order to build nineteen of these barges, which will be 150 by 20 by 12 feet.

The Pacific Marine Corporation has been incorporated in California, and is building a plant at San Diego. The organization will be operated by the Scofield Engineering Company, of Philadelphia and San Francisco, and will build concrete-steel vessels.

The Canadian Allis-Chalmers Company, Toronto, Can., state that they can fill six berths before June, 1919, and will begin work as soon as berths become vacant.

Shipbuilding Contracts Awarded by the Shipping Board

The United States Shipping Board, Emergency Fleet Corporation, Washington, D. C., has awarded contracts as follows:

To the Seaborn Shipyards Company, Tacoma, Wash., P. J. Anderson, purchasing agent six more ships of the Ferris type, making a total of fourteen ships of this type for which the Seaborn Company has orders.

To the Wright Shipyards Company, Tacoma, Wash., George P. Wright, president, two ships of the Ferris type.

To the Pensacola Shipbuilding Company, Pensacola, Fla., six 9,000-ton steel steamships.

To the Marine Department of the Houston Bank & Trust Company, Houston, Tex., two concrete ships, each of 1,600 tons deadweight capacity.

To the Lake & Ocean Shipbuilding Company, Cleveland, Ohio, three seagoing tubs.

To the American Lumber Company, Panama City, Fla., eight 2,500-ton seagoing wooden barges, at its new shipyard in Millville, Fla.

To the Nilson & Kelez Shipbuilding Company, Seattle, Wash., John Erickson, president, two more 3,500-ton wooden ships.

To the Biddeford Shipbuilding Company, Biddeford, Me., a 3,000-ton wooden barge.

To the Universal Shipbuilding Company, Sturgeon Bay, Wis., which took over the wooden shipyard of Rieboldt, Wolter & Company, three sea-going tugs. This yard is also preparing to build steel vessels.

To the Richard T. Green Company, Chelsea, Mass., a large number of 240-foot coal barges.

To the Bethel Marine Railway, Bethel, Del., two 2,500-ton wooden sea-going barges.

To the Midland Bridge Company, Houston, Tex., eight 3,500-ton wooden steamships.

To the Ames Shipbuilding Company, Seattle, Wash., Edgar Ames, president, fourteen 8,800-ton steel steamships.

To the Atlantic, Gulf & Pacific Company, 13 Park Row, New York, eight three-masted wooden coal-carrying schooners, to be built at a new yard on Mill Island, Jamaica Bay.

Savannah Firm Will Build Oil Tankers for Government

Preparations are being made to lay the keel of the first of ten oil tankers to be built by the Terry Shipbuilding Corporation, of Savannah, Ga., for the Emergency Fleet Corporation.

The contract for the ten tankers is understood to represent a total of about $16,000,000, the cost of each vessel being $1,600,000.

ITALIANS STRIVING FOR QUALITY NOT QUANTITY IN SHIPBUILDING

Plan to Build 500,000 Tons a Year

An article which recently appeared in *Giornale d'Italia* discusses the prospects for the Italian shipbuilding industry after the war. The old Italian shipbuilding yards, it says, which were extended immediately after the beginning of the war, will be able to turn out more than half a million tons of cargo boats per annum, and in two years they will be more than able to bring the Italian mercantile fleet up to its pre-war standard. In four years they will be able to double the size of the fleet, but that will still be inferior to Italy's needs.

"We must not even think of competing with England and America in quantity of production. That would be absurd. We must equip our yards not only for cargo ships, but also for mixed vessels for carrying both cargo and passengers. It is a different form of construction, finer, and one which demands more labor, and therefore one which is better suited for us."

For this class of vessel there will be a great demand, because the war has also played havoc with passenger ships, especially for the transport of troops. And there seems to be no reason why, with this type of ship, fine, elegant, well planned, Italy cannot enter into competition even with England and America.

Shipments of Steel Plates and Other Forms of Steel to Be More Closely Supervised

In order to remedy the inequalities that have existed thus far in the service given the shipyards by the steel mills a new blank or form of report has been issued by the Director of Steel Supply at Washington. On this report the requirements of steel of the various forms for each month, as determined by the Emergency Fleet Corporation, and sanctioned by the Director of Steel Supply, are shown in one column and against these amounts actually shipped.

Ferris Type Ship Framed in Fifty-nine Hours

The framing of a Ferris-type ship by 60 men in 59 working hours is a feat accomplished by the Cumberland Shipbuilding Company, Portland, Me.

The work was done on United States Shipping Board Emergency Fleet Corporation Hull No. 386. All of the 71 square frames, together with the stern post and the 60-foot keelson, were permanently erected by four framing crews of 12 men each, 6 riggers and 6 setters-up.

PACIFIC COAST MERGER

Four Million Dollar Deal in Shipping Closed

The Pacific Steamship Company, according to recent reports, has taken over the entire passenger and cargo fleet owned by the Pacific Coast Company. The absorption of the Pacific Coast Company brings under the control of the Pacific Steamship Company a unified fleet, and it is believed that the latter company will make an effort for traffic to the Orient, South America, Australia and possibly other trades after the war.

Operated Under One Flag

With the consummation of the absorption the Pacific Coast Company will retire from the ocean. Until November 1, 1916, it operated its vessels under the name of the Pacific Coast Steamship Company. It then entered into an agreement with the Pacific Alaska Navigation Company, by which the fleets of the two corporations were merged and placed in operation under the flag of a new company, now well known and well established as the Pacific Steamship Company.

Vessels Involved

The vessels involved in the new deal include the *President, Governor, Senator, Queen, City of Seattle, Spokane, City of Topeka, Curacao, Ravalli* and *Homer*, the latter operating in the California coast trade. The *Umatilla*, another Pacific Coast ship, was wrecked several months ago on the Japanese coast.

The original fleet includes the *Admiral Dewey, Admiral Evans, Admiral Farragut, Admiral Wainwright, Admiral Nicholson, Admiral Watson, Admiral Schley, Admiral Godrich, Admiral Sebree* and the *Aroline*. Recently the Pacific Steamship Company purchased the auxiliary-powered schooners *Admiral Sims* and *Admiral Mayo* as a means of extending its transportation operations.

Take Over Entire Plant

The Universal Shipbuilding Company, Sturgeon Bay, Wis., has taken over the entire plant and equipment of the Hess Iron Works, Inc., and will erect several buildings to effect a transfer of the works to its shipbuilding plant. W. J. Hess, general manager of the Hess Iron Works, joins the Universal company as superintendent of fabricating and boiler manufacture. The purchase will enable the Universal company to accept contracts for steel vessels. The company at present is building ocean-going tugs for the Government. These tugs are to be 150 feet long, with 30-foot beam and 16½-foot draft. They will be driven by triple-expansion engines.

Bids for New Plant

Bids are about to be taken by the Weehawken Drydock Company, Weehawken, N. J., for the erection of a shipbuilding plant to be erected at Peekskill, N. Y.

Town Grows With Shipyard

Pascagoula, Miss., which for years was merely a small village on the shore of Mississippi Sound, has increased to 20,000 permanent population by the establishment of the Dierks-Blodgett, the International and other shipyards there. Moss Point, formerly a swamp, with a few houses and stores, a short distance from Pascagoula, has passed the 5,000 mark and is driving on to 6,000 as the result of the establishment of the Dantzler and Hodge and other yards.

Special Shipworkers' Train

The Emergency Fleet Corporation has arranged with the Louisville & Nashville Railroad for a special shipbuilders' train to ply between Biloxi and the shipyards at Pascagoula, both in Mississippi. Shipyard workers at Moss Point, a suburb of Pascagoula, where there are several yards, are enabled to connect with this train by means of an electric car line which connects the two towns. This train will carry the workers from the yards of the Dierks-Blodgett Shipbuilding Company and the International Shipbuilding Company at Pascagoula, and the Dantzler and Hodge companies at Moss Point. More than 3,000 men are employed at the Pascagoula yards and more than 2,000 at Moss Point.

Recent Launching

The Alabama Drydock & Shipbuilding Company, Mobile, Ala., recently launched a 10,000-ton mine sweeper and a 2,500-ton composite ship.

Shipyard Loafers Become Good Workers Through Novel Idea Suggested in Spirit of Fun

Ship workers at the plant of the Los Angeles Shipbuilding & Dry Dock Company have adopted as their slogan "Don't Delay the Ships." This slogan, however, is not only a battle cry but a command which each workman is required to obey in spirit and in deed. To enforce their edict the men have established a tribunal known as "The Court," which for effectiveness and originality is a marvel.

Created in a spirit of fun, this court has long since ceased to be a mere means of amusement. Instead, it has been converted into an effective agency for speeding up the work, and is a real menace to those who might be disposed to take things easy and let the other fellow hustle.

The court is presided over by the head of the shipwright department, and reaches to all departments of the shipyard. Each defendant is given a fair and impartial hearing at sessions held during the noon hour. The full power of the judicial body is given him in the matter of summoning witnesses. Counsel is provided for those who demand it. If the accused be found guilty he is "executed" in public, usually before an audience of hundreds of his fellows.

Harking back to the witchcraft days of the old Massachusetts colony, "The Court" has taken for its instrument for punishment the ducking-stool. The number of immersions is regulated according to the seriousness of the offense. One trial and sentence is usually enough; as yet there have been no second offenses.

Argentina Shipping Active

Owing to the reorganization of the important river fleet of Nicolas Mihanovich, tending to a redistribution of the fleets, the company has recently added to its fleet the *Leda* of 570 tons, the *G. B. Vierci* of 578 tons, two tenders, two launches and a tug—seven boats in all at a cost of $153,400.

It is reported that the steamer *Benjamin*, of 1,117 gross tons, belonging to Messrs. Larraerrea, Milans y Cia., has been sold at a high price, and that the vessel will be placed on the route from Buenos Aires to Barcelona. This vessel was built in 1902.

It is also reported that the fleet known as the Lambruschini fleet has been sold to Señor Debernardir, Montevideo, for $340,655, consisting of four tugs, four schooners, all under 400 tons, and other small vessels. It is understood that the owners, known as La Naranjera Rosarina S. A., are considering an offer for their fleet, consisting of eight river boats.

Experiments are being made with rafts on the Parana, in view of the high price of vessels. Recently a raft constructed by Messrs. Nnñez, Gibaja, Martinez y Cia., some 80 meters in length and 17 meters in width, arrived in Rosario carrying 2,000 metric tons of cedar, lapacho and other wood for Buenos Aires. Many delays were met in the passage, but it i sbelieved this form of transportation will prove practicable in handling timber from Formosa and the Chaco.

London Shipowners' Society Head Urges England to Declare Ship Policy

J. Howard Glover, chairman of the London General Shipowners' Society, in the course of his address at the recent annual meeting of that body, strongly urges England to name its ship policy. Mr. Glover spoke in part as follows:

"I hope my successor next year may be able to give us some words of light and leading as to the future of our trade. To me it is all dark at present. The Government is now owner of a great many cargo ships, and the newspapers tell us that when the programme is complete 500 ships will be owned by the Shipping Controller.

"What is the policy of the Government with regard to these ships and their control of trade? Has not the time arrived when we should be enlightened as to this? One result of Government control is that a large number of shipowners have been permitted to sell off their fleets and go out of business, and some have lost nearly all their ships through enemy action.

"It seems to me that the Government should endeavor now to sell the standard ships, so as to enable the shipowners to preserve their business and personnel. I think ,if it is possible, it would be a wise course, and I am certain from a financial point of view alone—apart from any others—it is the interest of the nation that these ships should be sold now.

"We hear of the enormous preparations for the production of ships—in this country, in the United States and in Japan. The figures mentioned are colossal, and, if true, will take but a very short time for the world's tonnage to more than recuperate all the losses

caused by enemy action. I think we may be faced with a difficult situation in the near future which will require very careful handling.

"It should be the first duty of the Government to preserve the shipping trade of the country, and to foster by every means in its power the trade of shipowning and shipbuilding, and I must not forget ship broking and all that this important branch includes. For the past two years this essential department of the shipping trade has been paralyzed.

"The greatness of this Empire has been built up by the fact that our mercantile marine are the carriers of the world. It was ships that made India and made our Colonial Empire. If the day should come when the supremacy of the carrying trade of the world passes from this Island Empire to others, a very serious situation would arise.

"I cannot end without saying that I think the Government's attempts to be merchants, shipbuilders, shipowners and ship brokers—all directed from Westminster—have not been, and are not, conducive to the advancement of the nation or the preservation of the vital interests of this Empire, and that every effort should be made to relinquish all the controls at the earliest possible moment. A beginning can easily be made now by the authorities ceasing to be shipowners."

War Emergency Courses in Employment Management

Intensive training in employment management for men and women having a basic experience of at least three years' industrial experience and knowledge of factory methods has been arranged for in the following universities: Harvard University; Massachusetts Institute of Technology; Boston University; Bureau of Municipal Research, Rochester, N. Y.; University of Rochester; Carnegie Institute, Pittsburgh; University of Pittsburgh; University of Washington, Seattle; University of California, Berkeley. Courses are also in preparation at the University of Cincinnati and at the University of Chicago.

The courses, which run from six weeks to two months, are conducted by the Employment Management Division of the War Industries Board, under the auspices of the Department of Labor, the War Department, the Navy Department, U. S. Shipping Board and the Chamber of Commerce of the United States.

No tuition fee will be charged. Employers having candidates for the courses and individual applicants desiring information should address Captain Boyd Fisher, Employment Management Division, War Industries Board, 717 Thirteenth street, N. W., Washington, D. C.

Emergency Fleet Corporation to Build 75 Deep-Sea Trawlers

Owing to the loss in vessels and small producing units which American fisheries have suffered through the war, and particularly by naval drafts, the Emergency Fleet Corporation, at the request of the United States Food Administration, has authorized the construction of a fleet of 75 deep-sea trawlers of the most modern type. These vessels, through arrangements with the fishing industry, will be put into operation early in 1919 on both the Atlantic and Pacific coasts.

All Contracts Cleared Through Fleet Corporation and War Industries Board

According to a recent ruling, in future each Government agency shall prepare its own plans and specifications for such ships or other water craft as it may require, conferring and collaborating from time to time with other interested agencies, to the end that uniform standards as nearly as practicable shall be adopted.

If an agency of the Government other than the Emergency Fleet Corporation desires and requests it, the corporation will, where practicable, undertake to construct, or to have constructed, proposed vessels according to the plans and specifications prepared by the agency.

In any event *no contracts for the construction of vessels will be placed by any such Government agency until they have been cleared through the Emergency Fleet Corporation and through the War Industries Board.* In the event of disagreement between the agency proposing the construction and the Fleet Corporation the controversy shall be adjusted or decided by the War Industries Board.

Through pursuing this course the activities of all of the different agencies of the Government interested in the construction of water craft will be coordinated, competition will be eliminated, and conflicts in supplies of materials, transportation, power, fuel and labor will be avoided.

Shipping Men Fear Loss of Technically Trained Men Through Increase of Draft Age Limit

Widening of the age limits of the draft to include all men between eighteen and forty-five years is causing much concern among shipping companies of this city whose organizations have already been impaired through the enlistment or drafting of many of their employees. Some difficulty will be caused by the induction into service of those under twenty-one years, but these can probably be replaced by women workers and those who may be exempted from the draft. The chief anxiety is felt because the upward extension of the age limits will bring within the scope of the draft a large number of the older and more experienced men occupying positions of high responsibility.

There is no disposition among shipping men to seek exemption of men whose services can be dispensed with, or for whom substitutes can be found. The business, however, is highly technical, and executive, or even semi-executive, positions cannot be filled from the ranks of untrained applicants, according to the experience of the trade to date.

Newburgh Launches First Overseas Craft

A 9,000-ton freight carrier, the first transatlantic steel ship to be built on the Hudson River, was launched from the Newburgh shipyards early in September. This yard now has under construction nine other ships, four of which are rapidly nearing completion.

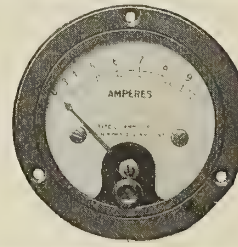
Shortly after Hull No. 1 left the ways the keel of No. 6 was laid on the smoking incline.

Meters for Wireless High-Frequency Work

A high grade hot wire measuring instrument, designed particularly for wireless and other high frequency work, has been developed by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

This conducting strip, made of special non-corrosive material, has a slight sag, which is magnified several hundred times on the scale by means of a combination of wires and a deflecting spring. The meter depends for its operation upon the expansion of a metal strip which is heated by the current to be measured.

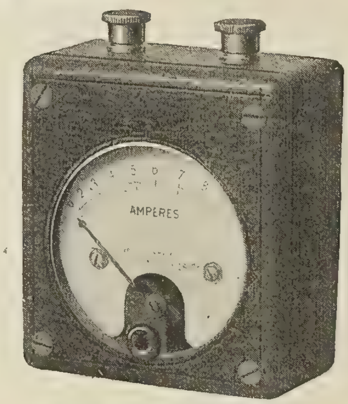
The separating posts have the same temperature coefficient of expansion as the conducting strip, so that the changes in room temperature do not cause error in the reading of the instrument.



Type E H Switchboard Ammeter

These instruments are furnished in two forms—for flush mounting and portable. Similar instruments for switchboard mounting are also supplied.

The flush-mounting form, known as type EH, is of the round, open-face type. The face is 3 inches in diameter, and the diameter outside the flange is 3¾ inches. It has a black rubberoid case and rim, with white dial.



Type P H Portable Ammeter

The portable form, known as type PH, is mounted in a morocco-leather-covered wooden case with heavy glass over the dial. The case is 3¾ inches by 4⅜ inches by 2 inches thick.

Type EH meters have a guaranteed accuracy of 2 percent, while type PH, with hand-marked scale, can be expected to show an accuracy within 1 percent of full scale. Standard meters are for 1, 3 and 5 amperes. Care must be used not to subject the instrument to more than 200 percent load.

The scale plate is made of metal, and the scale subtends an arc of 90 degrees, being 2⅜ inches long.

Bonar Law Analyzes Shipbuilding Situation

In introducing the record vote of credit for £700,000,000 in the House of

Commons recently, Bonar Law pointed out that the national expenditure instead of exceeding the estimates was under them. Analyzing the figures from the beginning of the financial year up till July 30, he said that, on the assumption that the expenditure was spread equally over the whole year, the amounts would have come to £726,500,000. The actual expenditure was £724,000,000, so that the estimate had not been reached to the extent of £2,500,000, equivalent to £24,000 per day.

Honor Badges for Ship Workers at Foundation Yard

Immediately after the double launching of the steamships *Bologan* and *Bugaya* on August 29 at the Passaic River yard of The Foundation Company, honor badges were presented by representatives of the U. S. Shipping Board to the men who had been employed continuously at the yard since the keels of

Honor Medal for Ship Workers

these ships were laid. The men at the Passaic River yard are the first, it is claimed, to receive recognition from the Shipping Board for faithful service by the presentation of badges shown herewith bearing the names of the ships upon which the men have worked.

According to the present honor roll system, 1,251 men were entitled to honor badges. The presentation of these badges was an unusual and interesting feature of the launching ceremony.

Shipping Board Takes Over Lake Steamer "Missouri" for Training Ship

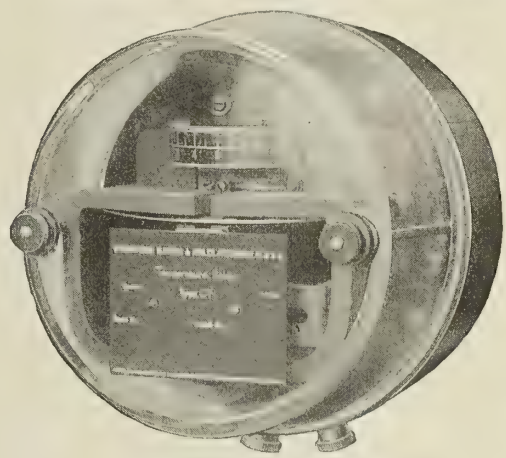
The Shipping Board announces that it has taken over the lake steamer *Missouri* as a training ship for merchant marine apprentices on the Great Lakes. The steamer, which will accommodate about 300 recruits, besides necessary officers and instructors, is now at Milwaukee. It will be stationed at a training base at Cleveland, under the supervision of Captain Irving L. Evans, of that city, section chief of the Board's recruiting service, and will cruise in the different lakes. Men trained on her will be given supplementary training on lake cargo carriers before they are sent to seaports for service on overseas and coastwise ships.

Making Temperature Trip the Circuit Breaker

The oldest form of overload protection is electromagnetic, cutting off the current if it reaches a value deemed dangerous. The fact that most electrical apparatus can withstand momentary overloads without danger has gradually led operators to push up the current values at which electromagnetic protective devices will operate, or to dispense with them entirely, rather than undergo the inconvenience of having them disconnect the machinery on momentary peaks.

A method of visual protection on the basis of temperature was the next step. Exploring coils were built into the apparatus, and used to indicate the temperature of hot spots by means of electrical instruments.

The latest step is a relay, the type CT, built by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., which automatically trips the circuit breaker when the temperature reaches the danger point under excessive current. It may be used to protect any alternating current apparatus from excessive heating if the apparatus is so arranged that exploring coils can be installed.



Westinghouse Relay Circuit Breaker Actuated by Temperature

The relay is intended to protect apparatus against overheating from sustained overloads. To afford this protection with the least interruption of service the breaker should be tripped through the direct effect of the temperature of the apparatus. The relay should be so arranged that it prevents the breaker from tripping if the overload is of such short duration that the temperature does not rise to a dangerous value; while if the overload persists the breaker must be tripped out as soon as the temperature rises beyond the critical value. This is accomplished in the type CT relay as follows:

The type CT temperature relay operates on the wheatstone bridge principle. Two arms of the bridge are copper exploring coils, arranged to be placed in the oil or embedded in the windings of the apparatus to be protected, the other two arms are unchanging resistance mounted in the relay. The current for the bridge is supplied by the current transformer connected in the circuit of the apparatus to be protected.

The relay has two windings, corresponding to and co-operating to produce torque in a manner similar to the current and voltage coils of a wattmeter. The main winding is a coil operated directly by the current transformer. The auxiliary coils are connected to the wheatstone bridge arms similarly to a galvanometer connection, and thus receive current, the magnitude and direction of which depend upon the resistance of the search coils.

Above a certain temperature the torque of the relay is in the contact direction, and below in the opposite direction. It will thus be noted that in order to close the contact, two predetermined conditions must co-exist—excess current and excess temperature. Neither one will separately trip the relay.

The type CT relay is similar in construction to the other Westinghouse types, except that it has special windings and two additional terminals.

The construction of the exploring coils will vary, depending on the kind of apparatus with which they are to be used.

STEAMSHIP MEN MEET

At the annual meeting of the American Steamship Association, held recently at 17 Battery Place, the following officers were elected for the coming year: President, H. H. Raymond; vice-president, Edward J. Barber; secretary and treasurer, W. M. Brittain, and attorney, Edwin H. Duff. The executive board selected consists of H. H. Raymond (chairman), H. F. Alexander, G. S. Dearborn, P. A. S. Franklin, Edward J. Barber, F. D. Mooney, W. H. Pleasants, Alfred Gilbert Smith, H. B. Walker and D. T. Warden.

The association comprises more than sixty members, representing steamship owners on the Atlantic, Pacific and Gulf coasts.

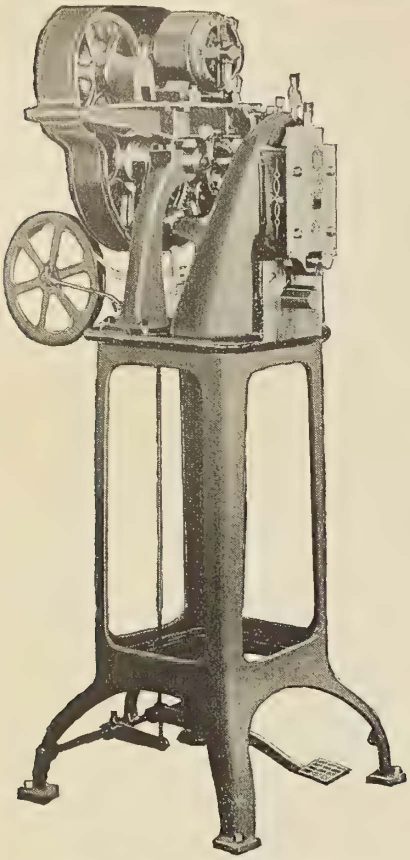
Box Corner Staying Machines

The Knowlton corner staying machine makes a strong and high-grade box by welding the sides of the box and the stay together under great pressure, forming a corner stronger than the board. The board is neither punctured nor weakened, but stiffened by the continuous fastening, and reinforcement is secured at each box corner.

This machine is manufactured by the M. D. Knowlton Company, of Rochester, N. Y. A Westinghouse motor, which can be connected to the lighting circuit, provides the power. It is mounted on the top of the frame, and is geared direct to the machine for individual drive. The stayer can be mounted on casters, so that it can be easily moved about the factory to any desired place.

A feature of the machine which is of special interest is the Knowlton safety device, which replaces the old-style driving link in the machine head. It serves a double purpose—of a pressure transmission and as a protection to the operation. The safety device is designed in such a manner that when the head is

lowering there is no driving connection until the head comes within a distance of approximately 5/32 inch of the anvil.



Knowlton Corner Staying Machine

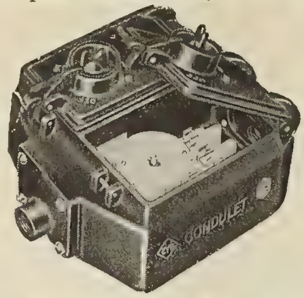
Any obstruction thicker than this prevents the device from locking and so exerting pressure. Thus this insures that it is impossible for the operator to be injured between the head and the anvil.

Last Word in Small Motor Switches

Herewith are shown illustrations of two switch Condulets of the ZY series—the latest additions of the large family of conduit fittings manufactured by the Cross-Hinds Company, of Syracuse, N. Y. As safety-first fittings, ZY Condulets seemingly leave little to be desired. It is claimed for them that they protect the switch operator and the person renewing fuses from shock; they cannot be operated by accident; they withstand the roughest usage; water will not drain into them, and it is impossible for lint or other inflammable particles to lodge upon the current-carrying parts, and thus create a fire hazard.

Both the body of the Condulet and its cover are cast iron. Inside is a combined 20-ampere snap switch and fuse block. The switch is externally operated, and its handle interlocks with the latch of the door in such a way that the latter cannot be opened when the switch is in the "on" position. As a result of this arrangement, the circuit is dead when the door is open, and fuses can be replaced without danger of shock or short circuit.

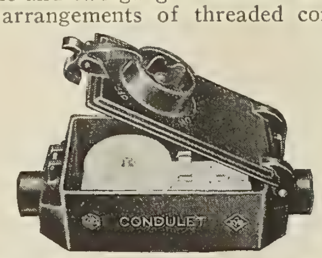
As the machine operator or any other person not skilled in electricity can change fuses with perfect safety in ZY Condulets, their use prevents all the loss in productive time, which is unavoidable where an electrician must be sent for to replace fuses. This, in the course



Type ZYU Two-Gang Through Feed

of a year, means a considerable saving in the operating time of the average mill.

The manufacturers list ZY Condulets in one and two-gang forms and in sizes and arrangements of threaded conduit



Type ZYC One-Gang Through Feed

hubs to meet various conduit wiring arrangements. They have also issued a folder on ZY Condulets which they will mail free to any address, upon request.

Shipbuilding Course Inaugurated at Lehigh

In order to meet the demands in shipbuilding and future demands in ocean transportation, a three-year course in ship construction and marine transportation will now be a part of the curriculum at Lehigh University. The course, which will include naval architecture, marine engineering and foreign commerce, began September 12, and will have the same entrance requirements and the same basis of mathematics and sciences as the other engineering courses.

President Hurley Suggests Miniature Boats as Toys

With a view to instilling the juvenile mind with the idea of a merchant marine, manufacturers have notified President Hurley of the Shipping Board that they will follow his suggestion of manufacturing millions of miniature boats. The boats will be made up in such a fashion as to bring home as forcibly as possible to the youngsters the plan of building up a great merchant marine.

New Ruling of War Trade Board

Under a ruling by the War Trade Board no vessel under the American flag will get bunker coal unless her wireless apparatus is so fitted that messages cannot be sent without the knowledge of the master. The master is held responsible for seeing that no message is sent to the enemy, that no reports are made of vessels sighted or of any weather conditions experienced, and that no messages except for emergencies can be sent within 200 miles of England, France, Portugal or Italy.

SHIPYARD NOTES

Changes and Extensions at the New Jersey Shipbuilding Yards

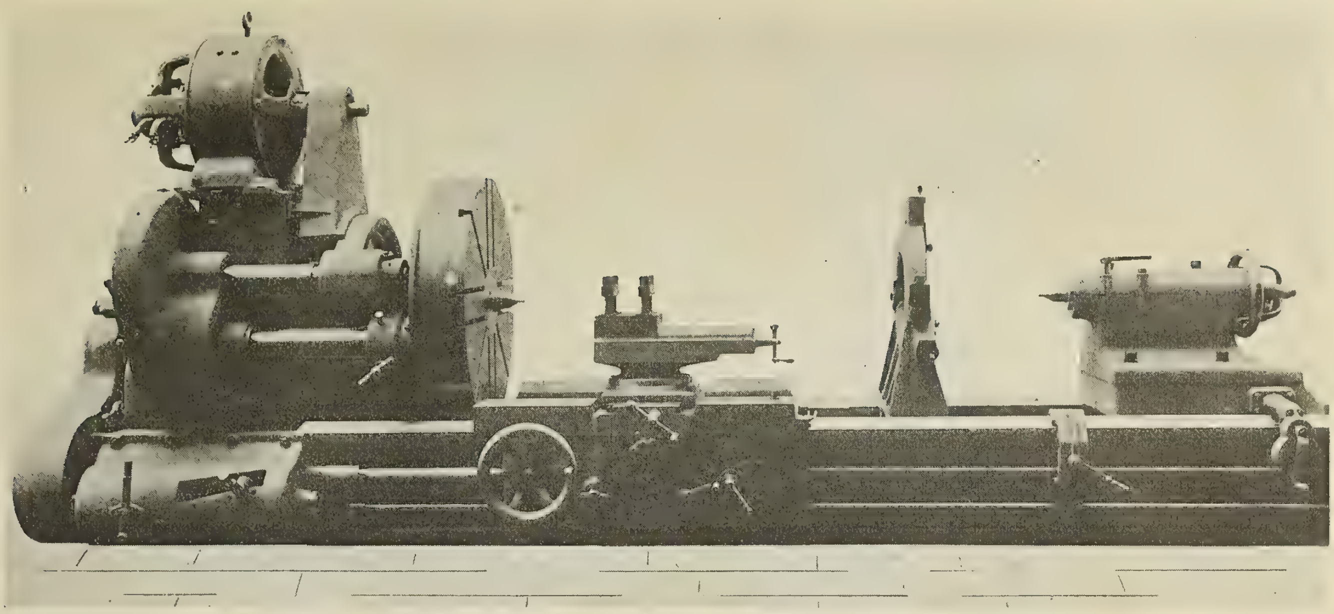
The Emergency Fleet Corporation, Philadelphia, Pa., has formerly taken over the shipyards of Pusey & Jones, Wilmington, Del., at Gloucester City, N. J., heretofore known as the Pennsylvania Shipbuilding Company and the New Jersey Shipbuilding Company, respectively. It is understood that several changes and extensions are contemplated to facilitate operation and increase the present speed of production. In this connection, M. E. Davis will remain as general manager of both plants. For several months past J. G. Barstars, treasurer of both yards, has been appointed on the board of directors of the company by the Government. Hugh V. Ramsey is general superintendent of both shipyards. In connection with this action of the Emergency Fleet Corporation the following changes have been announced: George W. Beatty to be assistant superintendent of the yard of the New Jersey Shipbuilding Company; Frank Breckenridge, assistant superintendent of the yard of the Pennsylvania Shipbuilding Company; S. E. Krause and S. E. Southard, assistant and private secretary, respectively, to the general manager. George S. Hoell, Philadelphia, has resigned as office manager of the yards, and will be succeeded in this position by Mr. Whittison. Mr. Hoell was one of the officials of the Pennsylvania Shipbuilding Company when first organized, and will become associated with the Delaware River Dredging Company.

Loss by Fire

Following the loss by fire, September 11, of the plate and angle shop and electric power plant, located at the lower end of the main yard of the New York Shipbuilding Company, Camden, N. J., plans are under way for replacing the structures. The loss, including equipment, is estimated at over $300,000. This section of the plant has been devoted to the production of torpedo boat destroyers for the Government, the shops being employed for the manufacture of steel and iron parts; at the time of the fire five such boats were in course of construction, and owing to the extensive facilities now provided at the plant there has been but slight delay in the continuing of construction. New torpedo boat destroyers are being completed rapidly at the works, launchings having been made about every week during the past month. The yard is also building a number of colliers as well as vessels of other types.

New Construction Under Way

The Union Shipbuilding Company, Fairfield, Md., has plans under way for the construction of its proposed new shipbuilding plant on water-front property recently acquired in this section. The initial works will consist of from six to ten shipbuilding berths, with machine shops, foundry, forge, forge shop, boiler plant, mold loft and other departments. The buildings will be of steel and concrete construction, and fully equipped for the production of wooden vessels. The plant will be operated in conjunction with the other works of the company in this district.

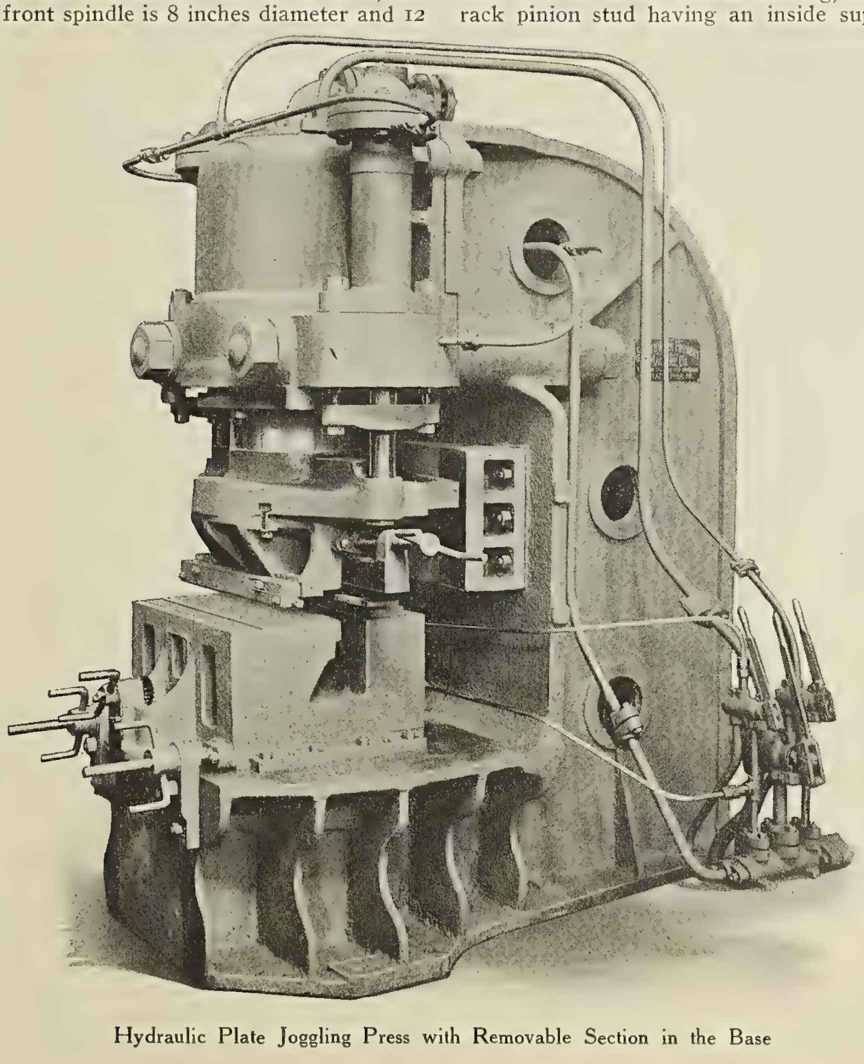


Heavy Lathe for Work in Marine Shops and Shipyards

Fifty-Inch Swing Lathe for Propeller Shaft Work

The Pittsburgh Machine Tool Company, Braddock, Pa., is marketing an exceptionally rigid lathe, furnished with either motor or belt drive, for heavy work in the shipyards. The head stock of the tool has a ratio of 68 to 1, the front spindle is 8 inches diameter and 12 inches long, the gear face is exceptionally wide, and the head is built with either cast iron or steel gearing, as preferred. The tail spindle and center are very large diameter. The carriage is designed with the idea to easy handling, and is therefore very sensitive.

The apron is of double plate construction with all studs double bearing, the rack pinion stud having an inside support. All gears are steel in the apron, the shafts are case-hardened and ground, and the carriage is made with a quick return and motor driven, if so desired. These lathes are constructed in any length of bed desired, and altogether offer a wide range of service in marine engine or shipyard work.



Hydraulic Plate Joggling Press with Removable Section in the Base

Plate Joggling Press for Use in Shipyards

The Southwark Foundry & Machine Company, Philadelphia, has recently placed on the market a new 200-ton plate joggling press, the equipment of which includes special dies consisting of a main lower die section and an upper pressure die, which is fastened to the ram, the lower die section being cut away to permit channels and bulb angles to pass through at right angles to the horizontal centerline of the machine.

The upper die is equipped with an adjustable slide and a taper wedge for changing the amount of joggle. The dies are arranged to joggle both right and left hand and have a capacity for 12-inch channels or equivalent sections.

The lower dies have three vertical rams and one horizontal one which is employed for clamping the work. Two of the vertical rams are operated by hydraulic pressure and are used to hold the material straight while joggling is being done, as well as acting as stripping dies when the pressure is relieved.

The center ram is operated by a wedge and handwheel at the front of the machine. The whole lower die block has a horizontal adjustment through handwheels and screws to center of the die for different classes of work.

The rams operate under a hydraulic pressure of 1,500 pounds per square inch, and the clearance from the face of the ram to the table is 39 inches.

The machine has open-hearth steel castings for the main top and bottom openings and the main ram, which is 20 inches in diameter with a 12-inch stroke, is equipped with hydraulic side pullbacks.

A removable section in the base of the

machine enables it to be used as a manhole punch. When handling this class of work it is nominally operated direct from a 1,500-pound pressure line, but may be operated with a low pressure filling system if desired. The operating valves are placed so as not to interfere with the operator's view of the work. The throat of the machine is 30¼ inches deep and the table 4 feet square. The floor space occupied by the machine is approximately 8 by 10 feet.

War Trade Board Rulings

The War Trade Board announce that a general import license, to be known as PBF No. 26, has been issued, covering the importation of surplus ships' stores and supplies, which the Bureau of Transportation of the War Trade Board may order to be removed from vessels in United States ports.

Walworth Company Adopts "War Finish" Wrench

With the idea of releasing labor and conserving material and fuel the Walworth Manufacturing Company, Boston, Mass., at the urgent request of the War Industries Board will discontinue the manufacture of the 6-inch genuine Walworth Stillson wrench, also the manufacture of the wood-handle genuine Walworth Stillson wrench in all sizes (making only the steel handle); and have adopted the "War Finish" as a standard finish for genuine Walworth Stillson wrenches for the duration of the war.

No change whatever will be made in patterns of quality of material or workmanship in the wrench proper. A tag will be attached to each wrench giving the reasons for the change to "War Finish" standard.

Although the "War Finish" wrench presents a rougher appearance, it is the same sturdy, dependable tool that has been made by the Walworth Manufacturing Company for nearly fifty years.

New York University Establishes New Course in Marine Insurance

In preparation for trade conditions following the war the School of Commerce of New York University has announced in its curriculum this fall a course on Marine Losses and Average Adjustments. The course will be given by Hugh A. Mullins, manager of the loss and adjustment departments of Parsons & Eggert and Marsh & McLennan. It will be part of the foreign trade curriculum of the Wall Street Division, and the classes are expected to be as large as those in the Marine Insurance course, which was inaugurated last year and will be continued during the coming sessions, with William D. Winter, third vice-president of the Mutual Insurance Company, as instructor.

Prof. A. W. Taylor, director of the Wall Street Division, upon explaining why it was considered expedient to establish this course said:

"Marine insurance is a vital factor in the development of our merchant marine. It is quite possible for marine insurance companies to discriminate against vessels belonging to foreign countries, and it is asserted by some that the inferior classification given to American vessels by foreign companies in the 60's and 70's, with the consequent higher rates demanded, was an important factor in the destruction of the American merchant marine. Now that we are building ships again and are extending our credit in foreign countries, there has come a rapid increase in the number of marine insurance companies on this side of the water to meet the new situation, and there is a demand for men trained in this branch of insurance.

"The business of marine insurance is divided into two more or less separate divisions, first that of underwriting, which involves the consideration of the risk to be taken, and, second, that of adjustment and losses, and, in short, the adjustment of losses is quite as important as the taking of the risk. Notwithstanding the fact that marine insurance is the oldest form of insurance, it is probably the least known in this country."

An extended series of lectures has been prepared for this course.

Shipfitters' Classes at Franklin Union, Boston

Walter B. Russell, director of the Franklin Union, Boston, has issued circulars announcing the reopening on October 22, 1918, of the classes in Ship Design and Calculations and Blue Print Reading for Shipfitters.

The class in Ship Design and Calculations is starting its fifth regular season, and will be conducted on Tuesday and Thursday evenings of each week to April 17, 1919.

The course covers the preparation of a set of ships' lines, midship section and general arrangement plans, areas and centers of plane and solid figures, Simpson and trapezoidal rules, weights and moments, displacement, block coefficient of fineness, center of buoyancy, transverse and longitudinal metacenters, trim of ships, etc.

Following the precedent adopted last season, the course will be open to women desiring instruction along the above lines.

The class in Blue Print Reading for Shipfitters, which was started last season, will be conducted on the same evenings as the class in Ship Design and Calculations.

This course provides instruction for men actually engaged in shipfitting and allied trades, and covers the definition of the various conventions used on ships' plans, the sketching of connections of structural ship work and the practical interpretation of working drawings.

American Screw Propellers

The American Screw Propeller Company of Philadelphia, designers of screw propellers and propulsive experts, announce that they have designed the propellers for over 450 vessels now building and on contract. This company's clientele now consists of nearly fifty of the largest American and Canadian shipyards, ten prominent steamship lines, eight naval architectural and engineering concerns, and a number of engine builders. They are also designers of marine propeller wheels for all classes and types of vessels.

RECENT LAUNCHINGS

The troop ship *Saccarappa*, the second of Hog Island's large fleet of cargo carriers and troop ships, was successfully launched on August 24. The *Saccarappa* was given her name by Mrs. Woodrow Wilson.

The mine-sweeper and mine-layer *Sanderling* was launched early in September at the Tebo Yacht Basin, Brooklyn, of the Todd Shipyards Corporation. Miss Dorothy Baine was the sponsor. The vessel is 180 feet long, 35½ feet beam, 18 feet deep, with a speed of from 14 to 15 knots. She carries oil, being an oil burner, and has also wrecking appliances. The contract for the vessel was signed on March 28 last year, and the keel was laid about June 1. This is the fifth vessel of this class launched at the Tebo Basin. Three have been delivered to the Government out of a total of the ten ordered.

The steamer *William L. Stead*, a vessel of 13,665 gross tons, built for the Pan-American Petroleum & Transportation Company, was launched on September 2 at the Fore River yards of the Bethlehem Shipbuilding Corporation. The steamer was named by Mrs. Paul H. Harwood, wife of the president of the company, for William L. Stead, superintendent of the Mexican Petroleum Company of California.

The vessel slid from the ways with such momentum that she struck on a ledge on the opposite bank of the river and slightly dented a plate.

PERSONAL

Charles Skentelbery, marine superintendent of the New England Fuel & Transportation Company, Boston, Mass., for the past eleven years, has resigned his position in that company and has associated himself with the Warren Transportation Company, 35 Congress street, Boston, Mass., as general manager.

G. A. Tomlinson, federal manager of the New York & New Jersey canals, has been appointed director of the Division of Inland Waterways, with office in Washington, D. C.

The Weiss Engine Company, executive offices, Edison building, 72 West Adams street, Chicago, announce the election of the following officers: President, Lucien I. Yeomans; vice-president, Carl W. Weiss; vice-president and general manager, Charles B. Page.

A. H. Morner, general manager of the Bolinder's Company, whose New York offices are at 30 Church street, New York, recently arrived from Sweden to take charge of the American business.

A. J. Barnes has been appointed export manager of the Shepard Electric Crane & Hoist Company, with headquarters at Montour Falls, N. Y. Mr. Barnes will also continue to be director of publicity.

OBITUARY

Anthony Weston Dimock, for many years well known in New York City as financier, explorer, steamship owner and author, died suddenly on September 13 at his country home in Happy Valley, Catskill Mountains. Mr. Dimock was born in Yarmouth, N. S., August 27, 1842.

NOTE.—The entire contents of this magazine have been passed by the Publication Approval Committee of the Emergency Fleet Corporation.

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The Port of New York

Commissioner of Docks Hulbert, of New York City, asks for $20,000,000 (£4,210,526) to be spent during the next four years on improving dock facilities. He quotes figures showing that in 1917 there was a gain of only 5 percent in exports from the port of New York, whereas Philadelphia showed an increase of 50 percent, Baltimore 30 percent, Boston 27 percent, etc.

It would be a great help to the port of New York to have the several new docks built for which the commissioner asks an appropriation, but merely to build the docks is not going to help the port of New York materially. With the enormous increases that are taking place, and that are sure to continue to take place during the next three or four years, in the tonnage of American ships and the export trade, New York needs a great deal more than new docks. Indeed, to hold business, it is absolutely necessary that existing docks in every instance possible be equipped with efficient machinery for handling miscellaneous freight, and that any new docks which are built should be so constructed that their prime object shall be simply to house all freight handled largely, if not entirely, by machinery.

Statistics published by the Federal Government in 1912 show that 300,000,000 tons of miscellaneous freight were handled twice at marine terminals during the previous year; that is, the freight had to be delivered at the terminals of origin and hauled away from the terminal of final delivery. Practically all of this freight, indeed it could be said that all of it, was handled by hand and other antiquated and inefficient methods. The best authorities on the subject of freight handling estimate that there is a potential saving of between $30,000,000 (£6,315,789) and $60,000,000 (£12,631,578) in handling this volume of freight. In general terms New York handles half of the marine trade of the country, so that by introducing proper and efficient freight handling machinery at the water terminals in New York there is a potential saving of between $15,000,000 (£3,157,894) and $30,000,000 (£6,315,789).

If New York does not start in at the first possible moment to revamp existing docks and build a large number of new docks that are properly fitted with machinery, the port of New York is sure to continue to handle less and less freight as the years go by and the American merchant marine increases in tonnage.

Technical Contributing

THERE is a great scarcity of technical men who can write interestingly on technical subjects. There always has been such a scarcity. Among the book publishers there is an axiom to the effect that men who have something worth while to write about cannot write about it acceptably, and those who do possess the knack of writing in an interesting manner have nothing about which to write. However true that may be in the field of fiction, if applied to engineering and to engineers it is a sure enough compliment, since a very small percentage of engineers write for publication.

There is great need for technical writers. Information of value to the engineering fraternities should and must be disseminated. Meetings held monthly or yearly among the several societies, while offering opportunities to the members to get up and transmit thoughts and experiences to others, yet these verbal utterances, which in great measure they are, do not offer the possibilities for wide distribution that comes of the written word and the printed page—the technical magazine. Here it is preserved for all time and eternity, since as a means of lasting preservation, the art of writing, as is well known, is second to none.

The editor of MARINE ENGINEERING wishes to encourage technical men to try their hand at writing for these pages. The rewards are many besides the one of money compensation. Reputations are made through the medium of continued contributing, such as are possible in no other way. Names become familiar to a wide circle of readers of the better sort, the writer's point of view becomes generally known, his personality is "sensed"—sensed as quickly as though by actual contact—and he one day receives a letter from someone in authority somewhere who wants him to round out the personnel of the establishment—salary the least of things to be considered.

Why not try your hand? However short, anything which you may submit will be given careful consideration.

Annual Meeting of Society of Naval Architects and Marine Engineers

THE twenty-sixth general meeting of the Society of Naval Architects and Marine Engineers, which will be held in Witherspoon Hall, Philadelphia, corner of Walnut and Juniper streets, Thursday and Friday, November 14 and 15, will begin each session promptly at 9:30 A. M. A good attendance is strongly urged—an attendance in keeping with the dignity of the organization. Much interest already has been provoked through the exceptional titles of the papers to be read, a list of which appears on page 657 of this issue, and we believe that, what with the many points of interest held out by Philadelphia alone—Hog Island, to name only one—a meeting of unusual excellence is promised. To this end we ask that each member exert every possible effort to be present at the meeting, and that while there he put forth every exertion to help make this a most successful and enthusiastic get-together. Membership in any organization implies attendance at

meetings as part of the price of initial admission. The Society of Naval Architects and Marine Engineers is no exception. Try to be there.

Need for More Destroyers

SIR ERIC GEDDES, First Lord of the British Admiralty, recently made a strong appeal to America on behalf of his government to expedite the construction of destroyers, anti-submarine craft and appliances of every description with which to further combat the undersea boat menace.

After creating some surprise by quoting Britain's high naval losses, and paying tribute to the United States for her immediate response to war requirements, Sir Eric reviewed the efforts of the United States and Great Britain, both general and naval. Among other things, he said:

"In men-of-war, by which I mean fighting ships of all classes, our losses since the outbreak of the war are approximately 230, more than twice the total losses of war vessels of the other allies. In addition to these losses, we have lost 450 auxiliary craft, such as mine sweepers and trawlers, making a total of 680.

"Turning to merchant ships, our losses since 1914 exceed 2,400 in number, representing a gross tonnage of nearly 7,750,000, being nearly three times the aggregate losses of our allies, and 50 percent more than the total losses of all other allied and neutral countries. We have also whole-heartedly devoted by far the major portion of our shipbuilding capacity to the construction of war vessels to maintain the sea communication of the alliance, to the detriment of our merchant marine."

That Great Britain neglected her merchant marine in order to build battleships was a keen-sighted measure. A merchant marine that was not properly protected would be like a sea-gull with a broken wing—a crippled and practically useless thing.

We in this country have taken the other stand and have constructed far more merchant ships than we have battleships. In so doing, we have held, with our allies, a sort of even keel in a matter of ship production. Yet we must not relax, even though swift events are upon us. Our policy of building up a merchant marine must be continued, even after all hostilities have ceased. Thus we will have proved our loyalty to all those nations associated with us, for it is obvious that our exports after the war will attain to a tonnage never equaled in the history of this country. Yet, as Sir Eric wisely points out, the war as yet is not won, and continued activity, even increased activity, in the construction of destroyers and anti-submarine craft and appliances is of inestimable importance.

10,000,000 Tons Shipping by 1920

A MONTHLY output of 500,000 tons of shipping before the end of this year is the expectation of the Emergency Fleet Corporation. This is one-fourth the tonnage delivered in the thirteen-month period of August, 1917, to August, 1918, both inclusive. If maintained for a year longer, it will mean 6,000,000 tons of shipping added to what has already been turned out, or close to a total of 10,000,000 tons by the end of 1919.

This calls for a tremendous increase in the dry dock facilities for taking care of the tonnage. A report of the United States Shipping Board Port and Harbor Facilities Commission makes recommendation for extensions at ports along the Atlantic and Pacific coasts. The principal extensions as provided for in the Deficiency Appropriation Bill before Congress are as follows:

Porland, Me., one 10,000-ton dry dock, floating repair shop and coaling plant, $2,100,000 (£442,105).

Boston, Mass., bonus for completion of the Commonwealth dock, $250,000 (£54,105); three 10,000-ton floating dry docks, repair shops, coal storage, etc., $6,500,000 (£1,368,421).

Providence, R. I.; Seattle, Wash.; Astoria, Ore., three 3,200-ton marine railways, $760,000 (£160,000).

Fall River, Mass.; New London, Conn., or Providence, R. I., one 10,000-ton dry dock, $2,100,000 (£442,105).

New York harbor, ten dry docks, 10,000 to 20,000-ton capacity, repair and other facilities, $25,000,000 (£5,410,540).

Philadelphia, three 10,000-ton floating dry docks and other facilities, $10,000,000 (£2,105,410).

Baltimore, one 10,000-ton dry dock and other facilities, $2,100,000 (£442,105).

Charleston, S. C., financial assistance for completion of 7,500-ton dock, $300,000 (£63,158).

Norfolk, one 10,000-ton floating dry dock and other facilities, $2,100,000 (£442,105).

Pensacola, Fla., one 5,000-ton floating dry dock, $350,000 (£73,473).

The facilities at New York and Philadelphia are the most important, and work will be rushed on them. They will not be completed for a year or more.

In testimony a few days ago before the House Committee on Appropriations, it was recommended by Charles Piez, vice-president of the Emergency Fleet Corporation, that the Government own the dry docks. He said it was found that private contractors were timid in going into the construction of these plants. The reason for this is that construction costs now are two and one-half times what they are normally. The plan for their building contemplates their continued use for the American merchant marine.

Mr. Piez believes that they will be needed after the war. "We have always depended," he explained, "upon the other side for repairs because we have had a very small merchant marine ourselves, but with a very much larger tonnage of shipping I think our repairs will probably be made in American ports."

San Francisco Wants to Be Free Port

SAN FRANCISCO, following the example of New York, is making a strong bid for a free port. William Kent, congressman from California, and a member of the United States Tariff Commission, a year ago laid the matter before the San Francisco Chamber of Commerce, and as a result a committee was appointed to investigate the subject and make a report. The report as made is as follows:

First.—It would benefit owners and charterers of ships, and strongly tend to build up a self-sustaining national merchant marine.

Second.—To the merchant, importer or exporter it would be of equal advantage.

Third.—It would simplify and systematize harbor administration. The incoming vessel would be freed from the present exactions of the Custom House regulations.

Fourth.—In customs administrations it would obviate delays due to customs boarding officers; would give prompt docking and uninterrupted discharge of cargo; would obviate heavy bonds to customs against loss by fire, theft, casualty, etc., and incidental delays, and the need of securing permits for early or late hour discharge. Bonded or foreign cargoes could be loaded or unloaded at will; vessels freed of delay from errors in customs papers;

custom officials given due notice of drawback goods. Also, there would be free teams on the docks, etc.

In conclusion, the report emphasizes the desirability of a quick decision by Congress in view of the enormous merchant marine in process of creation.

"The free port arrangement," says the report, "is simply a gigantic harbor facility, and we believe one that can be made most fruitful in its application to our country. It will take much time, labor and money to carry it out, and the period of indispensable preparation should not be postponed longer than is necessary."

October Was Shipbuilding Banner Month

DELIVERY of 400,000 tons of new ships this month is expected by the Shipping Board, following compilation of returns from the yards for the week ending October 18. During that week fourteen wood and steel vessels, with an aggregate tonnage of 77,150, were delivered. This figure, taken in connection with previous construction this month and the reported condition of ships that will be completed before November 1, leads to the expectation of a new monthly record.

Among the feats reported for the week was the completion of the 4,000-ton wood freighter *Aberdeen* at Aberdeen, Wash., in twenty-seven calendar days from the time of launching. Another fast construction was that of the *Invincible,* an 11,800-ton steel freighter, delivered by the Bethlehem Union Shipbuilding Corporation at Alameda, Cal., in 105 calendar days after the laying of the keel.

Requisitioned vessels delivered during the week totaled 30,900 tons, contract steel vessels, 28,250 tons, and wood and composite vessels, 18,000 tons.

The Shipping Board asked Congress for an additional $120,000,000 for the construction of vessels. The Senate Appropriation Committee will consider the request in connection with the Military Deficiency Bill, which is now before it.

An additional $1,650,921 was submitted by Secretary Baker for miscellaneous items, and the Department of Labor asked for $1,000,000 more.

We are making progress rapidly. Yet there lurks the contention in some circles that managerial efficiency is lacking in some shipyards. There may be some truth for this allegation. Certainly it is apparent that some yards turn out more ships per ways than do other yards. A labor handicap or a faulty supply of materials may be the answer. Either cause would reflect upon the management. Materials there are in plenty, and labor may be had if the proper means are exercised toward securing it. This is proved by the fact that some yards have sufficient of both. Then why the big difference in quantitative output between some yards and other yards? There is room for thought here, surely.

Notice Regarding Unauthorized Agents

SOME time ago we gave authorization to a Mr. Frank and a Mr. Fridman to secure subscriptions for MARINE ENGINEERING in the Great Lakes district. We have received several complaints from persons in this district, advising us that subscriptions have been given through these agents, and that copies of the magazine have never been received. These agents are not living up to their contract with us, nor are they sending us the names of the men who subscribe through them.

We hereby ask our readers to warn their friends of these two men, and to pay no money to them for subscriptions to MARINE ENGINEERING.

Stringerless Ships

UNTIL quite recently it was considered absolutely essential to the stiffening of the side plating of a ship that longitudinal side stringers should be fitted between the bilge brackets and the beam knees. Many vessels are now being built without side stringers, compensation being provided by slightly increasing the depth of the beam knees, these modifications being sufficient to satisfy the rules issued by the classification societies. Many advantages follow the elimination of the side stringers. In the first place, there is a considerable saving in the cost of construction of the vessel; moreover, there is additional cargo space, and the ship is very convenient to discharge, there being no shelves for the lodgment of such cargoes as grain or coal. Further, the increased depth of the bilge brackets either avoids or reduces the unsupported span of the frame between the bilge brackets and the beam knees, which admits of a reduction in the size of frame, so that it is possible to utilize bulb angle frames instead of built-up sections as provided for in former rules. It is open to question, however, whether it is structurally safe to dispense entirely with side stringers, although it is apparent that many builders are at least convinced of the advantages which result from this method of construction.

Much can be said and written on this subject. The shipbuilding world will view with interest the results of experiments along these lines. Ship structures, like all other forms of structure, may be subject to revision.

Marine Wages Are Good

The American merchant marine is the best-paid merchant service in the world. In war or peace, American seamen have always been better paid than those of other countries. After the outbreak of the great war in 1914, the earnings of American merchant marine officers, always liberal, steadily advanced, until they reached the highest level ever known.

The scale adopted by the United States Shipping Board in June, 1918, may be accepted as representative of the wages for officers on American vessels in the second year of America's participation in the war. It is given for illustration only, and in no sense as a guarantee of what an officer may receive on any given type of ship.

The wages paid under this scale on various classes of ships and for various kinds of voyages make too long a list to be presented here. Therefore, to the maximum and minimum only in the scale was added a bonus of 50 percent for voyages through the war zone.

A special bonus, one-half of that paid for service involving voyages through the war zone, was established for ships operating in Atlantic waters, but not to vessels plying exclusively in harbors, bays, rivers and sounds. The scale:

Rating	Pay per Month	With 50% War Bonus
Captain	$230 to $300	$345 to $450
First mate	140 to 165	210 to 247
Second mate	125 to 150	187 to 225
Third mate	110 to 135	165 to 202
Fourth mate	115 and 120	172 and 180
Chief engineer	160 to 230	240 to 345
First assistant engineer	140 to 165	210 to 247
Second assistant engineer	125 to 150	187 to 225
Third assistant engineer	110 to 135	165 to 202
Fourth assistant engineer	115 and 120	172 and 180

Graduates of United States Shipping Board schools serving as junior or sub-junior officers receive $90 a month with no bonus. Not a bad compensation in itself.

The Employment Manager in Our Shipyards

Duties of the General Executive—Importance of Schools—The Wage System and Ideal Service—Psychology of Mass Action

BY EDWARD D. JONES

THE general executive is a correlator. He is a balancer of claim against claim. His business is to define the general aim and to harmonize all lesser or intermediate achievements with it. To do this work well he must be supplemented by specialists who do not correlate or determine general aims or policies, but who concentrate upon some special phase and upon demand furnish to him standards and reliable standardized agencies. The line executive in war determines where a battery shall go and what it shall do, but he depends upon staff men to breed a reliable artillery horse and to design convenient gun carriages and likewise to prepare service tables for sighting guns.

In industry, and this means shipyards as well as other organizations, the function of staff departments is already seen clearly with reference to mechanical equipments. The general executive desires a works; but he depends upon the architect to design building members which will sustain the probable stresses. He desires a product; but he organizes a designing and drafting department to control the dimensions of parts. This principle of staff service is now being carried over into the field of human administration. General executives demand well-chosen men, men physically examined and pronounced safe for the work they are to do, men who, being properly paid and properly handled, may become permanent, contented and loyal cooperators in the general plans of the enterprise. Of all standardized agencies which a service department can put at the disposal of a general executive, the supreme one is a first-class man.

An Extension of the Division of Labor to Foremanizing

The distinction just drawn between line and staff represents a case of the application of the principle of the division of labor to administration. This principle is being applied rather vigorously just now at a lower level in the hierarchy of industrial administration. One of the merits of the movement known as "scientific management" was that it called attention to the absurdly wide range of functions which the average foreman was endeavoring to perform. Until a short while ago this officer was attempting in most establishments to hire men and set their wages and discharge them, to find work for men and machines from hour to hour, to recommend equipment for the shop and keep the equipment in repair, to give an offhand opinion as to when future work would be completed, together with what it would cost to maintain a stock of raw materials, to preserve discipline, and to furnish the office with such records as were required. It is needless to say that the degree of efficiency attained with such supervision was low. "The Jack of all trades is master of none." This quotation found its proof in machinery operated at a low percentage of its possibility, in time lost in hunting tools, in waste of stock, in delayed deliveries, in unreliable quality, and in inefficient, discontented workmen, who frequently vent their grievances in strikes.

The remedy is functionalization. This means that groups of related functions should be put in the charge of service departments, such as the stock room, the planning room, the tool room, the designing department, the pattern loft, the engineer in charge of repairs, and the estimates department. In conformity with this idea there has come into existence in thousands of businesses a department (whether administratively distinct or called by any name suggesting it or not) in charge of the supervision of a considerable portion of the relations between employer and employee.

In this way the foreman is relieved. He no longer is a "bouncer." He no longer sells jobs or practices nepotism or holds his pets in soft places. He has not the easy device of covering his own incompetence by firing a man. Instead, he must suggest a transfer which may show that his employee is able to give satisfaction in another shop where the foremanship is different. He gets a more even and dependable run of workmen from the employment department than he could provide himself. And, being free from other distractions, he becomes the teacher of the shop.

Vocational Guidance

Vocational guidance is a sister movement to vocational education. It has made much progress in connection with the work of the public schools, supplementing as it does parental advice, which no longer is adequate in these days of innumerable trades. It offers to the pupil a new reason for taking interest in his school work—namely, his interest in his own future career.

Vocational guidance has shown us the necessity of analyzing industrial tasks, to find out of what they consist, in what their peculiar difficulties lie and what qualities they demand of the worker. It has shown the need also of studying the mentality of the youth and endeavoring to understand his temperament, so that work may be found for him which accords with his talents, which possesses interest for him and which has power to evoke his enthusiasm.

This experience of the schools in the guidance of youth has caused us suddenly to realize that for most communities the only vocational counselor yet available is the man who does the hiring in factory or yard. So hiring takes on a new significance. It no longer consists merely of the work of giving out jobs; it is, or ought to be, vocational guidance. We demand for this important function skill and specialized experience and a high ideal of responsibility to the person employed.

The Evolution of Psychology

In recent years there has been budded off from philosophy a science of the mind which, adopting the laboratory process and following the conservative methods of inductive research, has accumulated a store of knowledge concerning the nature of the sensory impressions, the character of mental action, and the types of mental imagery. It has done much to aid in classifying the characteristics of personality and to define the various types of temperament. It defines for us various types of arrested development and various classes of unbalanced personalities.

This science now offers us the possibility of selecting from the applicants for jobs at a factory office those per-

sons who are adult in physical devlopment, but still have the minds of children. It identifies the self-centered paranoics and also those bright and optimistic persons who are certain, because of temperamental instability, to endure for a short time only, or to become truoblemakers.

As such persons may comprise from 5 to 15 percent of all applicants, the importance of careful examination is obvious. This identification is not for the purpose of refusing them work, but to give them work which is within their powers, and to provide them with a supervision which is more intimate and constant and forebearing than normal persons require.

Psychology also tells us much of the means of impressing the memory, of holding the attention and of arousing the interest. It explains to us what the learning process is. It pictures the various instincts and their corresponding emotions, so that we can see why there is attraction in matched records and in the idea of a game. In all this it leads up to and elucidates the simple but permanent basis of discipline and loyalty. Indeed, so fertile is this new science in suggestion, we can foresee the time in the near future when the employment manager will be expected to be well grounded in it and to keep himself in close touch with its evolution.

The Evolution of the Wage System

The conviction is general among employers that the setting of a wage rate is perhaps the most vital matter in the relation of employer to employee. The employer needs to have such investigations made as will reveal the current market rates for different types of labor power. He needs an expert to supervise patiently the prolonged process of forming a wage scale in which each job in the shipyard will find its proper relative place. It is coming to be realized that wages can never be made wholly satisfactory until greater definiteness is attained in measuring the basic factors involved in it, such as the worker's talent, the quality and quantity of effort required by the task, and the working conditions. Where low rates of pay are concerned it is essential to obtain the local cost of living by first-hand inquiries. Where excess performance is required it becomes a problem for the expert to say what excess above standard wages is required.

The ideal wage system is that of the man in business for himself. For such a man reward rises and falls in perfect accord with his performance. The endeavor of executives to approximate this wage, in the complexities of modern business, has led to the devising of many kinds of productive bonuses. Where these bonuses are sufficiently localized upon an individual plant and pertain to a sufficiently definite and measurable aspect of performance, and where they are properly founded upon an hourly wage rate and a standard of performance, they have given satisfaction. To plan such bonuses in strict accord with the conditions of the individual industry, the employer needs the services of a competent department.

Safety First

The sense of responsibility felt by the modern employer for his men has led to a movement to cut down the large toll of bruises, burns, infections, mutilations and deaths in industry. This impulse has been supplemented by workmen's compensation laws, which enforce responsibility upon those employers who do not voluntarily assume it. The study of accidents shows that they result for the most part from bad management, from equipment allowed to fall below standard condition, from lack of training, from labor turnover, from lack of physical examinations and lack of job analysis. Above all, they are caused by the absence of a judicious attitude of mind among employees. This fact puts the problem more largely within the domain of the employment manager than of the engineer.

Hygiene, Sanitation and Medical Aid

A great advance has been made in medical science in recent decades. This advance has laid bare the intimate relation between good water, ventilation, digestible food, regularity in private habits, and health in the home on the one side and accident rates, fatigue, irregularity in attendance at work, antagonism of mind, and strikes on the other. The complicated interlacing of these factors accounts for the profitableness of the health work which has been undertaken by progressive employers.

The Democratic Shop

It is needless to refer to the steady drift of industry toward democratic control. This drift may make itself felt to an employer as the mandate of law. It may come as the dictate of organized labor. On the other hand, if it is met with willing mind it may come into an employer's business in the form af a welcome co-operation with his employees, such as getting together to settle questions of common interest or as a process of taking from his shoulders a portion of the load of minor executive responsibilities. Through such a sharing the employer may give to his employees scope for suggestions and criticism, and he may give them a voice in determining working conditions. If he makes these experiments tactfully and sincerely he is altogether likely to find that production is improved, that the best employees seek his plant, and that discipline is largely self-enforced.

There is a wide field of activity having to do with the efficiency of the worker and including such matters as thrift, legal aid, insurance, pensions, housing and recreation, in which the employer will desire that as large a portion of the initiative may come from his employees as possible. The employment manager's task is to guide these activities into fruitful channels in as natural a manner as possible. He may be a sort of power behind the throne, but he should be modest enough to give the credit to others for what has been done, whenever possible.

The Ideal of Service

The ideals of truth and service for many years have been prominent in the world of advertising and selling. Only shortsighted persons still believe that to make a sale terminates a business relation. It is much more in harmony with the best practice to say that a sale begins a mutually profitable relation. Henry Ford once asked his agents to remember that they were not selling machines but selling transportation. If this concept of a service relation be carried into the interpretation of the labor contract, it will be seen that in reality an employer "sells" his job to the employee. He "sells him," or satisfies him, as to the wages, the working conditions, the task to be done, and the policies of labor management in general. Then his problem is to keep him "sold."

But it should not be a mere job that is sold. A permanent relationship should be entered into—a relation of mutual aid and protection. To quote Ford again, "It is not a living but a life we are trying to provide for our workmen." This ideal of service has led American business men to venture out constantly beyond what were once considered to be the boundaries of strict business. The surprise which has usually accompanied such ventures has been their profitableness. Where an employer has had faith, superior employees have gathered to him and built up a permanent and enthusiastic force around him.

The coming of the great war has intensified the strength of all these evolutionary movements. It has done so because the war has made efficiency seem more necessary and because these movements are all calculated to construct a more firmly knitted and economical social order. The present shortage of skill commends to us a stricter labor accounting, both in the labor market at large, at the hands of a public employment service, as well as within the individual business, through the work of an employment department. The same necessity brings us to intensive methods of training skill with careful vocational guidance, so that every man, young or old, may find his highest work. It implies, again, safety, sanitation and medical aid in industry to maintain the working force at par.

Enthusiasm for the common cause of country is a great lesson in the psychology of mass action for industrial leaders who have never learned the power of common cause with their workmen. Wages and prices have passed through such advances as to demand the closest attention to the wage-setting process. The great slogan "To make the world safe for democracy" is certainly being carried over from politics into the field of industry. Democracy will not require less skill of economical leadership than one-man rules; it will require more. And this is true because its aims are broader and because it attains its aims, not by brutal coercion, but by a process which requires a finer man. The process is one of persuasion and due compromise; it requires purity of purpose. To-day business management more than ever before needs a special class of executives who shall be its tribunes with labor and its statesmen in framing labor policies.

It has already been pointed out that the United States Employment Service has undertaken to supply war plants with labor; clearly it is incumbent upon the manufacturer to make the best possible use of that supply when it has been made available for him. The employer realizes this; he sees that, if the maximum of efficiency is to be attained, the efforts of the United States Employment Service in his behalf outside the plant must be supplemented by his own within. This means the reduction of his labor turnover, which in turn will mean increased production. The question that he asks himself is "How?" Under present conditions there is but one answer—improved working conditions for his employees. He must take the best possible care of his labor if he would keep it. His production and his credit with the United States Employment Service suffer if he does not. With this problem before him, the employer turns to his employment manager, from whom he has the right to expect advice as to definite methods to be pursued and suggestions as to the specific application of well-established principles to the particular problems of his plant. And the employment manager, so approached, renders decisions often of utmost importance.

Increasing the Frontage of American Seaports

What Was Done in Foreign Ports—Mechanical Appliances for Unloading—Mistakes of Early Port Engineers

BY H. MC L. HARDING*

ALL that most ports need for the present is to discharge and load ships, barges and lighters with greater rapidity; that is, three times faster than is done at present, utilizing their, often present, extensive piers and bulkheads. This is easily, quickly and economically possible. But to do this there must be no congestion points, either on the side of the pier, on the pier, at the entrance to the pier or elsewhere.

The above is equivalent in results to increasing the present berthing frontage three times. In addition, the short holding areas must also be equivalent to three times as much in holding capacity.

This is to be taken as an average.

No one would question that, if there were three times as many piers and bulkheads as at present, many ports would have a great surplus.

Not only is this three times the increase possible with the present linear frontage and surface area, but also the American terminal engineer naturally can improve on foreign installations in adapting them to American conditions.

Many other foreign ports having similar unfavorable conditions have obtained this threefold result. These pioneers learned their lesson many years ago, being forced to it by an active mercantile marine. They have written down the exact number of tons they were transferring when their conditions were the same as at certain American ports, and what the tonnage was after improving. They employed water (hydraulic), steam (the engine), and electricity (the traveling hoist).

At first the various ports tried different methods, but finally almost all foreign ports followed practically the same terminal principles.

A barge and lighter, even where two were lying side by side and were without masts, were unloaded by their mechanical appliances, which would have been impossible with cargo masts.

A space alongside of the pier, 8 feet × 8 feet = 64 square feet, easily congested by one or two winches per hatch, was not what they used for discharging ships, but served a space 40 feet × 100 feet, or 4,000 square feet, without rehandling or moving the machine. By these machines combined with the ship's winches, six packages or drafts were going through the air at one hatch at one time instead of, as is usual at Pacific ports, one, or at the utmost, two drafts. Instead of building new piers, by an investment of one-tenth the cost of a new pier they obtained equivalent results.

These port engineers, from their experience, realized evidently that operative conditions were factors of the greatest importance, and that a one-story shed without columns, without elevators, without chutes, without other floor incumbrances, was far less easily congested than when the unavoidable elements of a two-story shed were present. They also knew that a one-story shed, 30 feet clear space beneath the trusses, had a greater holding capacity than a two-story shed 36 feet in height. In the

* Terminal Engineer, New York.

one-story shed there were no obstructions; greater speed and less cost of operation, and less initial investment. They had learned from daily operation the value of conserving floor space, utilizing unoccupied air spaces, and the necessity of coördination between railway car and vessel.

Although not in their records, such early port officials probably made trial by error, which mistakes should not to-day be repeated by those just entering into a new era of port development, due to a great merchant marine and a domestic and foreign commerce unequaled in the history of the world.

There can be no doubt also as to which will be the great port of the Pacific whose commerce will equal that of the port of New York if it will avoid the mistakes of the past and profit from the experience of others. The port to which I refer is, of course, the port of San Francisco.

Effective Arrangement of Departments in Shipyard Organization

Shipyard Divisions—Relations Between Organization Departments and Production Departments—Duties of the Chief Engineer

BY G. F. S. MANN, B. S.

THIS article is written with a view to helping the new small shipbuilding companies that have been formed within the past year, and so will no doubt seem elementary to some of the older engineers who read it. Unfortunately there is a complete lack of modern organization in many of the smaller concerns now engaged in building ships, with little knowledge also of the different departments essential to the economic production of ships, which is lamentable. For it is only by having the necessary number of departments, each responsible for its own particular kind of work, that mistakes can be avoided, and that, when a mistake does occur, the man who is responsible for it can be quickly found and the mistake remedied.

A shipyard should be divided primarily into two parts, namely, the plant organization departments and the production departments. These are again sub-divided into many branches, as will be shown later. Unless the plant organization departments keep the yard properly equipped and in proper working order it is impossible for the production departments to build ships economically, and so the plant organization departments will be dealt with first.

Division of the Organization

The plant organization is usually made up of the following branches:

1. Main office (general manager).
2. Auditor's office.
3. Cashier's and purchasing offices.
4. Plant engineer's or maintenance department.
5. Material department.
6. Miscellaneous departments.

Most of the above names are self-explanatory, but the work of some of these departments will, nevertheless, be explained.

In the auditor's office are, (a) the accounting division, (b) the ship and the plant cost division, (c) the timekeepers, and (d) the piecework counters.

The plant engineer's department is responsible for all the engineering work of equipping the yard and maintaining it in working order. The installation and maintenance of tracks and the building of shipways is the work of the civil engineer, who is one of the plant engineer's staff. The work of erecting the necessary buildings and equipping them with proper machinery to do the ship work is done by the plant engineer, who is responsible also for the air, steam, electric and water lines.

The material department usually consists of the following divisions:

(a) Material agent.
(b) Requisition division.
(c) Receiving and shipping divisions.
(d) Transportation department.
(e) Accounting department.
(f) General storekeeper.
(g) Warehouse.

Among the miscellaneous departments are listed (a) the watchmen, (b) the employment office, (c) the dispensary, etc.

Division of the Production Side

The production side of the yard should be divided first into two parts, namely, the hull department and the engine department. Each of these is again divided into two departments, the hull department consisting of the naval architect and his draftsmen, and the yard hull department, which does the actual building of the ships. Similarly, the engine or machinery department has two divisions, these being the chief engineer, with machinery draftsmen, and the yard machinery department, which makes the machinery and installs it in the ships.

The usual departments in each of the above four main divisions will be explained next in the order in which they were mentioned.

The naval architect has to make the necessary corrections in the standard plans now issued by the United States Shipbuilding Board, report any errors which he finds, and supervise the hull drafting department, which should be divided into four sections, viz., the structural drafting, ventilating system drafting, the hull piping and the hull machinery drafting.

The yard hull department builds the hulls of the ships and installs in them that machinery which is commonly called hull machinery and also the hull piping. From this it will be seen that the work of the yard hull department covers many trades. The essential sub-divisions are listed below:

(a) The hull superintendent.
(b) Lumber shed and joiner shop

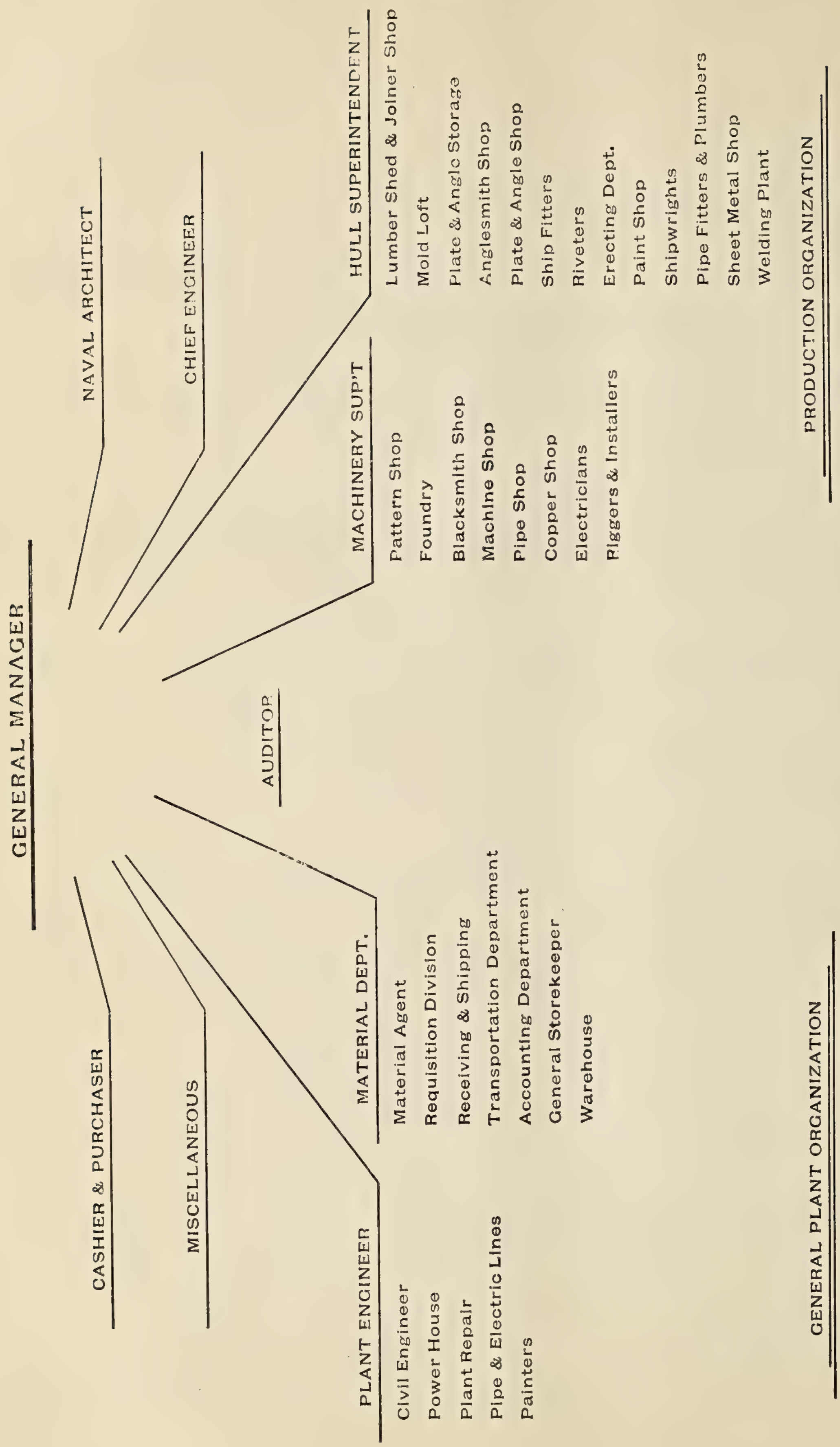

Fig. 1.—Diagram Showing Shipyard Organization Departments and Production Departments in Their Relation to the Office of the General Manager

(c) The mold loft.
(d) The plate and angle storage.
(e) The angle smith shop.
(f) The plate and angle shop (the fabricating shop).
(g) Ship fitters.
(h) The riveting department.
(i) The erecting department.
(j) The paint shop.
(k) The shipwrights.

The above are necessary for building the hull only, and the following departments are required for fitting the hull machinery and piping and rigging the ship:

(l) Pipe fitting and plumbing department.
(m) Sheet metal shop.
(n) The welding plant.
(o) The rigging loft and ship riggers.
(p) Laborers.

Division of Kinds of Drafting

The chief engineer directs the hull drafting room and may sometimes superintend the machinery installation in the ships. The engine drafting is usually divided into the following branches:

(a) Main engines and boilers.
(b) Propellers and shafting.
(c) Auxiliary machinery, such as pumps and condensers.
(d) Electrical equipment.

The yard machinery department is made up of the following branches.

(a) Pattern shop.
(b) Foundry.
(c) Blacksmith shop.
(d) Machine shop.
(e) Pipe shop.
(f) Copper shop.
(g) Electricians.
(h) Riggers and installers.

Summary and Conclusion

It is good practice to have, in addition to the above departments, one known as the superintendents' department. This will consist of the inspectors, men who follow progress, and the statistical clerks. Some of the small companies think that inspectors' and the progress department are quite unnecessary, not realizing that by efficient inspection a great deal of incorrect work which now has to be taken out of the ships and replaced could be avoided. I know of an instance of a ship having been planked for four working days without any attention being paid to the blue-print directions, with the result that four more days had to be spent in taking down this work, which was a total of eight days lost. I mention this merely to show how easily an inspector can save time and money for a company.

In conclusion, it seems to me that the simplest way to stop the wastage which still unfortunately occurs in many yards is to get the necessary departments established and then see that each of these is capable of doing its own work. If mistakes then occur it is an easy matter to fix the responsibility, after which steps may be taken to prevent a repetition of these mistakes, in so far as the human element, always an uncertain quantity, can be made to guard against them. System in an establishment will do this, however, provided the system is closely held to and taken seriously by all involved. In some shipyards to-day, system is a thing but little known.

American Shipping and Shipbuilding

The position and prospects of United States shipping and shipbuilding are provoking considerable speculation just now, says *Engineering* of London, and a few facts and circumstances relating to American conditions may usefully be set out. In view of her resources up to a few months ago and her available volume of skilled labor, America is now doing wonderfully well. Thus she is playing, and will play, a highly welcome part in helping to solve the shipping problem, and it is not unlikely that after the war that country will be our chief rival on the ocean carrying trade as she was in the first half of the nineteenth century.

In the middle of the last century the Americans came near to beating us in ocean shipping; and history may possibly repeat itself. Ambitious plans are being made for a permanent revival of the United States merchant marine. But we may rest assured that we shall not experience from America that kind of State-subsidized and bounty-fed undercutting of freights and passenger rates that characterized German competition before the war, and will govern it again if we take no measures to check it. American competition will be fair and above board, If, as is probable, American shipping is subsidized, it will only be to an extent sufficient to balance the difference between costs at home and abroad, in strict accordance with the protective principle of United States law.

Appointment of Shipping Board

Since the war started more than $250,000,000 (£52,631,790) of new private capital has been invested in American shipping enterprises, and perhaps an equal amount in shipbuilding. A Federal Shipping Board has been appointed with power to raise almost unlimited sums of money from the building, purchase and hire of vessels; and large amounts have been spent on extensions and improvements of the naval yards. When war broke out the tonnage of United States shipping engaged in foreign trade was only, in round figures, 1,000,000 tons, though the country possessed about six times that tonnage employed in the lake, river and coastal trades. Britain had 18,000,000 tons of ocean shipping, and Germany 5,500,000 tons. Only about 8 percent of America's oversea commerce was carried in American vessels.

The great boom in American shipbuilding and its twin trade shipping is not, however, a creation of the war, though it has been accelerated by war. It is part of a national movement for more ships, inaugurated before and apart from the war. More than twenty years ago a Merchant Marine League was formed in the United States to advocate the restoration of shipping. When it was found that the Panama Canal was at last likely to be opened to traffic the "more ships" question became one of practical politics. How far the current revival will be carried—how far American shipping will rise in the international scale—whether we shall be closely run or beaten by the Americans—will depend partly upon the measures that are taken to foster United States shipping, and partly upon our own efforts to maintain our supremacy. If our workmen and their unions are unreasonable, if our engineers will not adopt standardization and other economical methods, if our builders will not cooperate and combine, and if our statesmen will not recognize the rights of enterprise and stop unfair foreign competition, then nothing can prevent such a growth of American and German shipping and such a decline of our own as will spell the downfall of the British Empire. The subject is certainly worthy of considerable thought and speculation.

Fig. 1.—Boiler Being Placed Aboard Ship

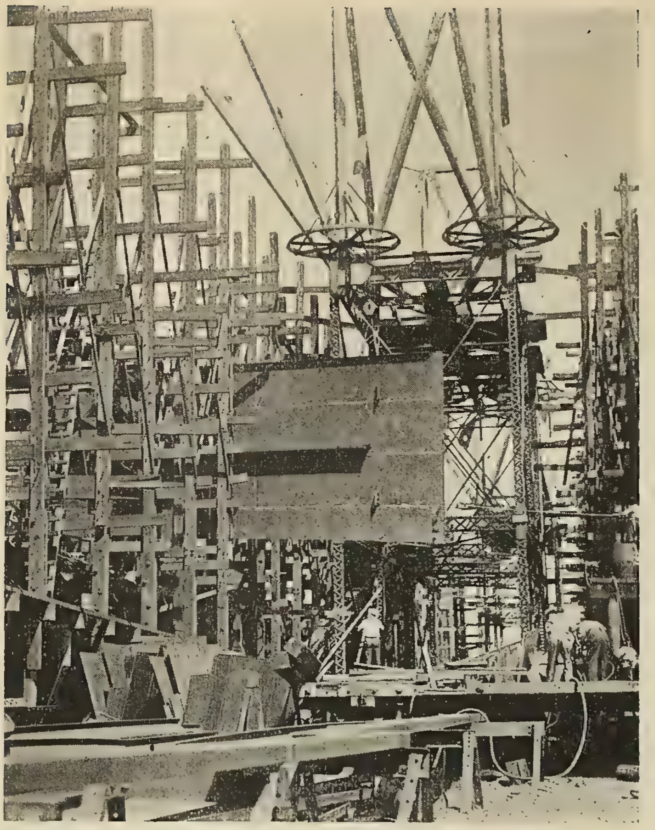

Fig. 2.—View of Ways Showing Plate in Suspension

Methods Used at Shooter's Island for Constructing Standard Ships

Serving Individual Ways—Method for Increasing Output—A Well-Lighted Boiler Shop—Handy Plate Lifting Clamp

BY CHARLES M. HORTON

WITH a record of 135 tons of fabricated steel a day—as against 65 tons a day a year ago—the Standard Shipbuilding Corporation, Shooter's Island, New York, is rapidly coming into the forefront as a producer among the Eastern group of yards. Ten standard type hulls already have been launched, with two additional United States mine sweepers, and six more ships are on the ways in various stages toward completion; all of which proves that the employees of the Standard Shipbuilding Corporation—there are seven thousand active workers on the payroll—are grimly driving rivets and punching steel.

The yard at present has six ways, with two more being constructed. Each is served by four towers and eight derricks. Notices posted prominently keep the workmen informed as to the date upon which the keel of each ship was laid and the scheduled time for launching. This acts as a spur to increased endeavor on the part of the men, and also engenders no little rivalry among the different groups at work upon their individual ships, since these daily bulletins conspicuously posted reveal the progress being made. "We're falling behind!" and "We're doing better, boys!" are two that struck the writer recently. These, painted in letters a foot high, so that he who runs with a bucket of oil may read, cannot but act as a strong incentive to extra exertion, especially when, as was the case for a time, bonuses are offered for records made in cutting down the time, over the scheduled date for launching, at which the ship is actually ready for the water.

Such measures for increasing the output are effective. That they bring other and larger rewards is betokened by the fact that recently the Emergency Fleet Corporation granted Shooter's Island the necessary money to increase the capacity of the yard by two additional ways, work upon which is already in progress. Instead of six, therefore, Shooter's Island will have eight ways before the end of the year.

The fabrication shop consists of five bays, two for boilers and three for plate. All material entering into the construction of a ship is unloaded from lighters directly into the storage yard, where it is handled by locomotive cranes and consigned to its proper place among its kind. Here each piece is carefully numbered and stamped for quick selection later. When it is required it is again picked up by the locomotive cranes and conveyed to a point just inside the particular bay where it is to be fabricated, and directly under the shop elecetric cranes. Then the electric cranes take it to workmen engaged in laying out and marking off. Each employee follows a certain fixed task, and with the plate in readiness for the shears or the punches, or the machines for planing, the overhead cranes are again brought forward and quickly convey the plate to the machines.

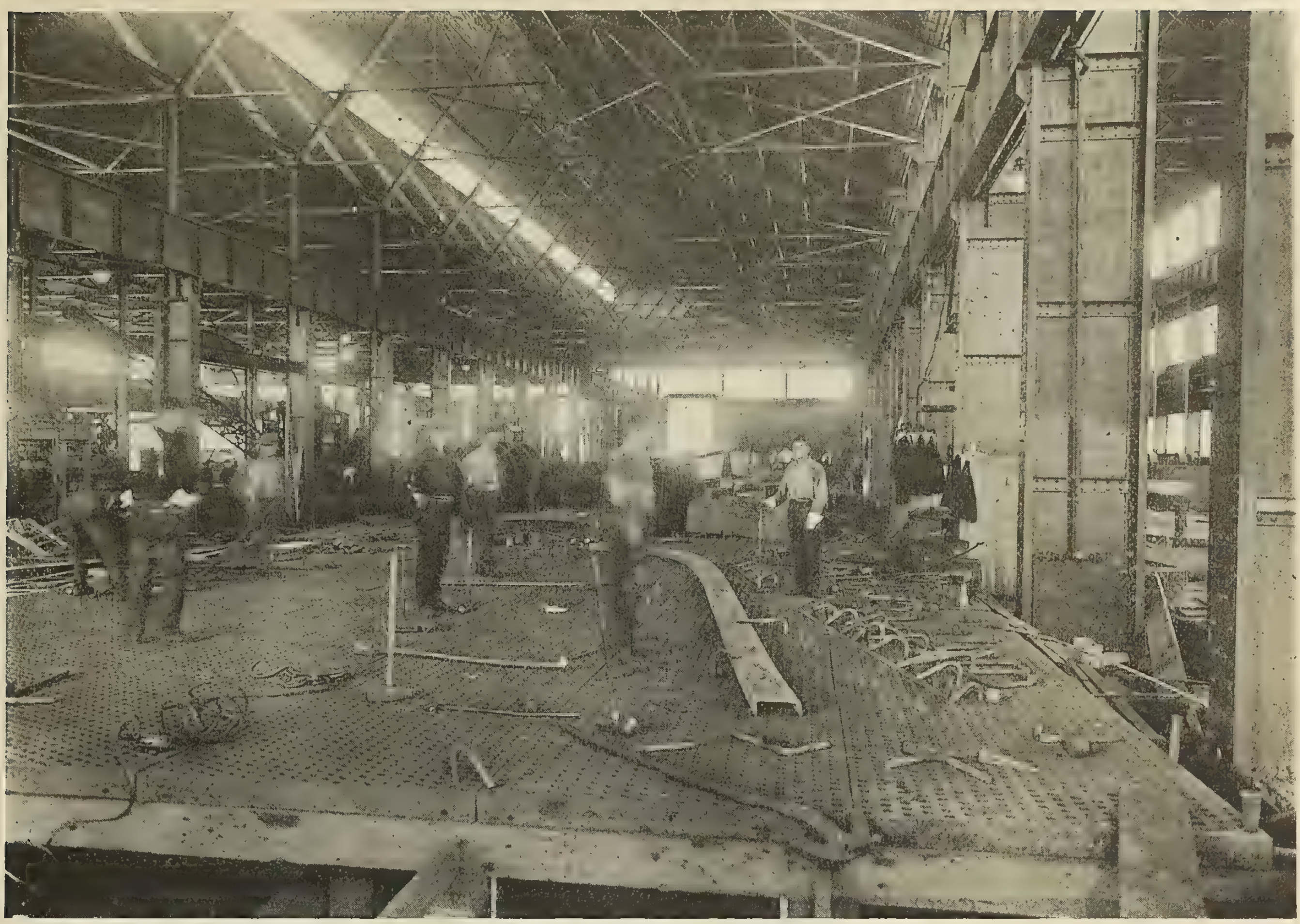

Fig. 3.—Interior of Angle Shop Showing Channel in Process of Bending

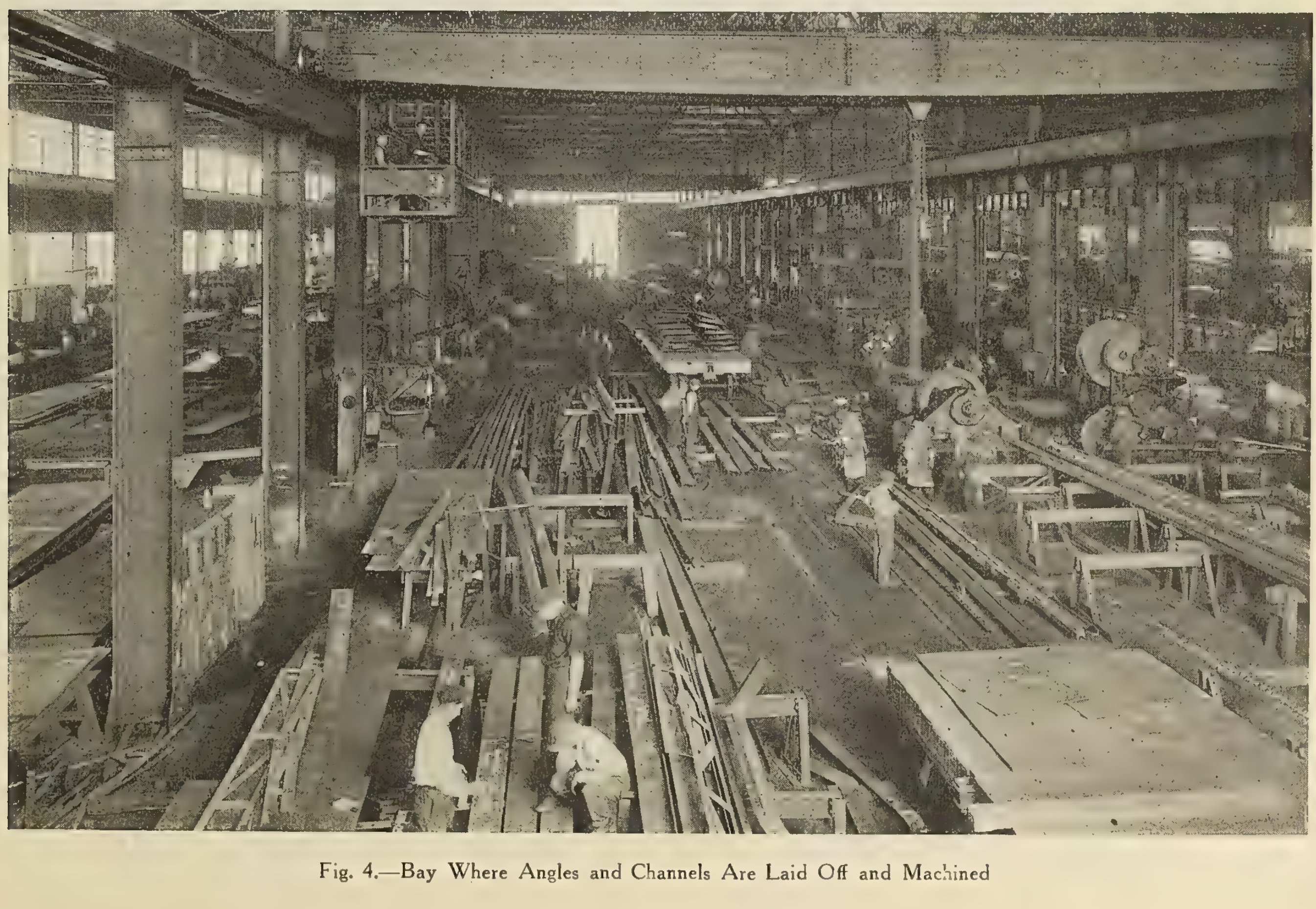

Fig. 4.—Bay Where Angles and Channels Are Laid Off and Machined

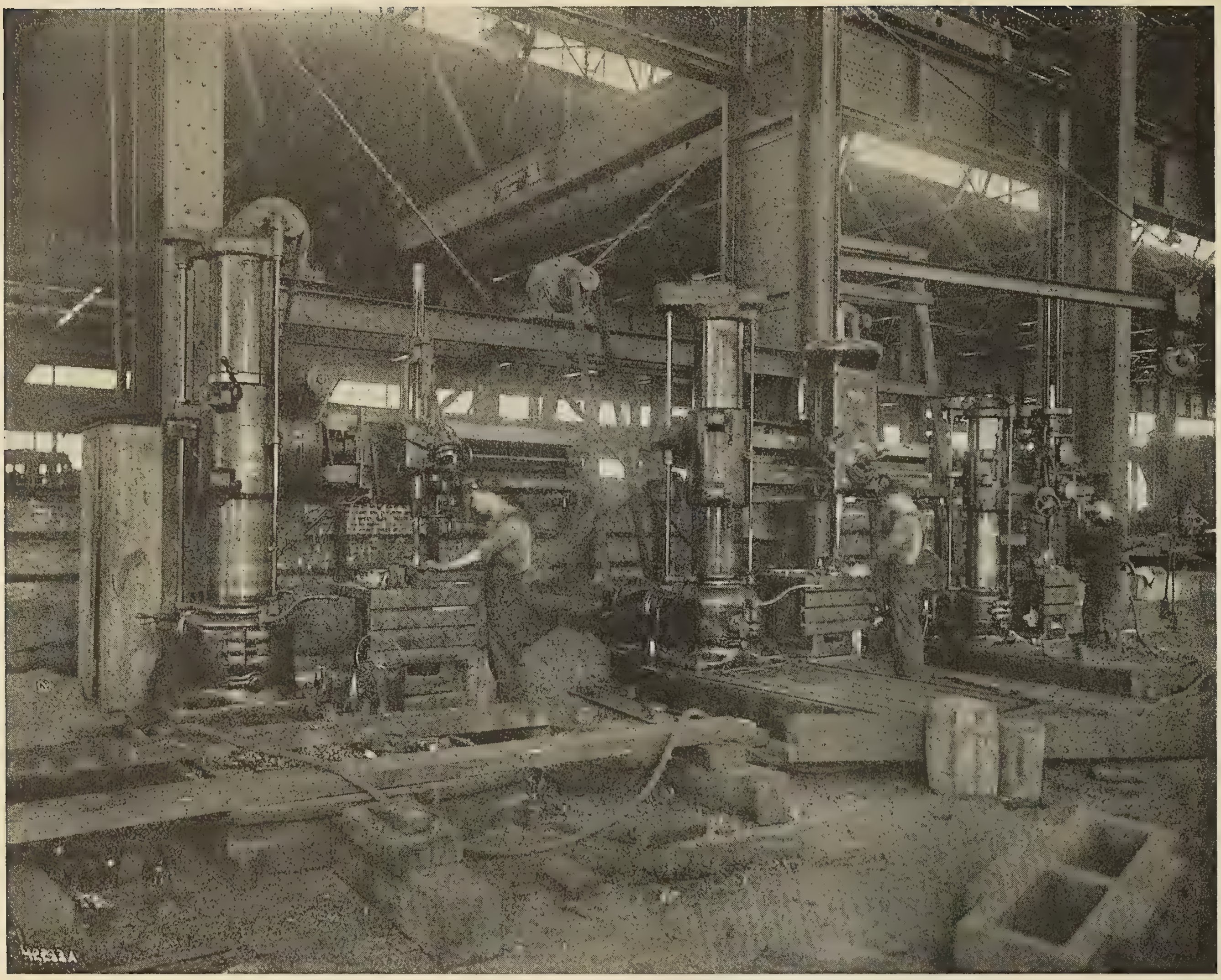

Fig. 5.—View Showing Gang of Drill Presses in Operation

There is in use in the yard a clamp that was patented by one of the foremen for the work of lifting plates. It consists of a lever bolted into a clamp in such a manner as to grip the plate through friction the moment pull is exerted upon the clamp by the overhead crane. As a device offering quick attachment and detachment, with a maximum of safety, it is beyond anything the writer has yet seen in use for this purpose, and unquestionably admits of increased efficiency in the work of handling plate material in the storage yards. It is capable of lifting two, and even three, plates at one time, and does this through no other holding device than the one exerted through plain friction. It would probably be well for the other yards in the Emergency Fleet Corporation to adopt this clamp, since its value has been well established in the yards at Shooter's Island.

The boiler shop, which is 400 feet long and 60 feet wide, is turning out boilers at the rate of one every six and a half days. The boilers are of the Scotch type, 14 feet 6 inches diameter and 12 feet long, with an indicated horsepower of 850. The shop just now is undergoing expansion, practically doubling its capacity, and with the extensions completed and the necessary new equipment installed, the output is expected to be doubled also.

The boilers, when in readiness to be transferred to the vessel, are hoisted by means of overhead cranes to flat cars, which convey them to the yard frontage where they are set aboard the ships as soon as these are launched. Very little delay occurs in lifting the machinery into place, once the vessel is afloat. This includes boilers as

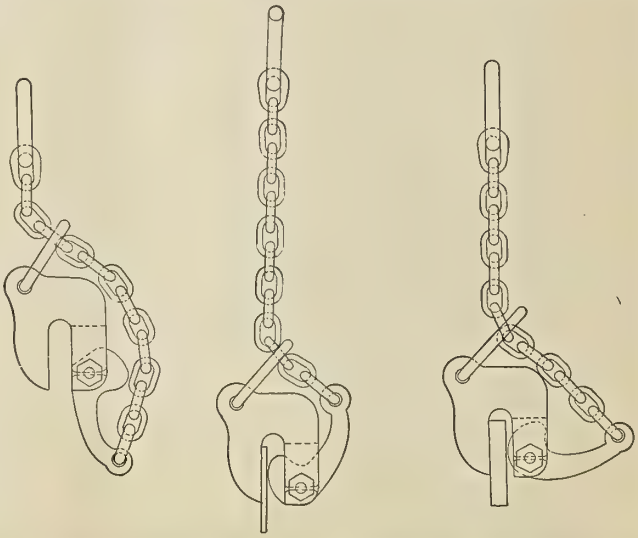

Fig. 6.—Sketch Showing the Various Positions the Clamp May Take When Lifting Plates

well as engines, auxiliary parts of engine room equipment and all the appurtenances.

To one looking down one of the bays of the boiler shop

where boiler heads are in process of shaping, it will be seen that there is plenty of light on the work, somewhat more than in many boiler shops, and in this light the work of shaping the heads proceeds in a systematic manner. The shop is roomy, as well as well lighted; and though there is much work going through all the time, but little sign of the usual boiler-shop congestion is in evidence in this bay. As a matter of fact, there is very great freedom of movement in evidence everywhere in the plant, considering its size.

Compressed air is the life of a shipyard, just as air at atmospheric pressure means continued existence to all animal and vegetable families. That H. Norman Scott, chief engineer, may know at any time the precise pressure under which the air guns are being worked, he has had installed in his office, immediately under his eye, a pressure gage connected directly with the yard piping. In this way, whenever the pressure falls off, he is informed of the fact, and quickly telephones the operating engineer in the compressor house, who promptly looks to his own gages, and rectifies the evil.

That is but one of a number of methods through which production is kept up to highest pitch. Another is the facility with which workmen coming into the yard resume

Fig. 7.—Patented Plate-Lifting Clamp

Fig. 8.—View Showing Boiler Shop Bay Where Heads Are Heated and Shaped

Fig. 9.—Section of Boiler Shop Showing Three Completed Scotch Boilers

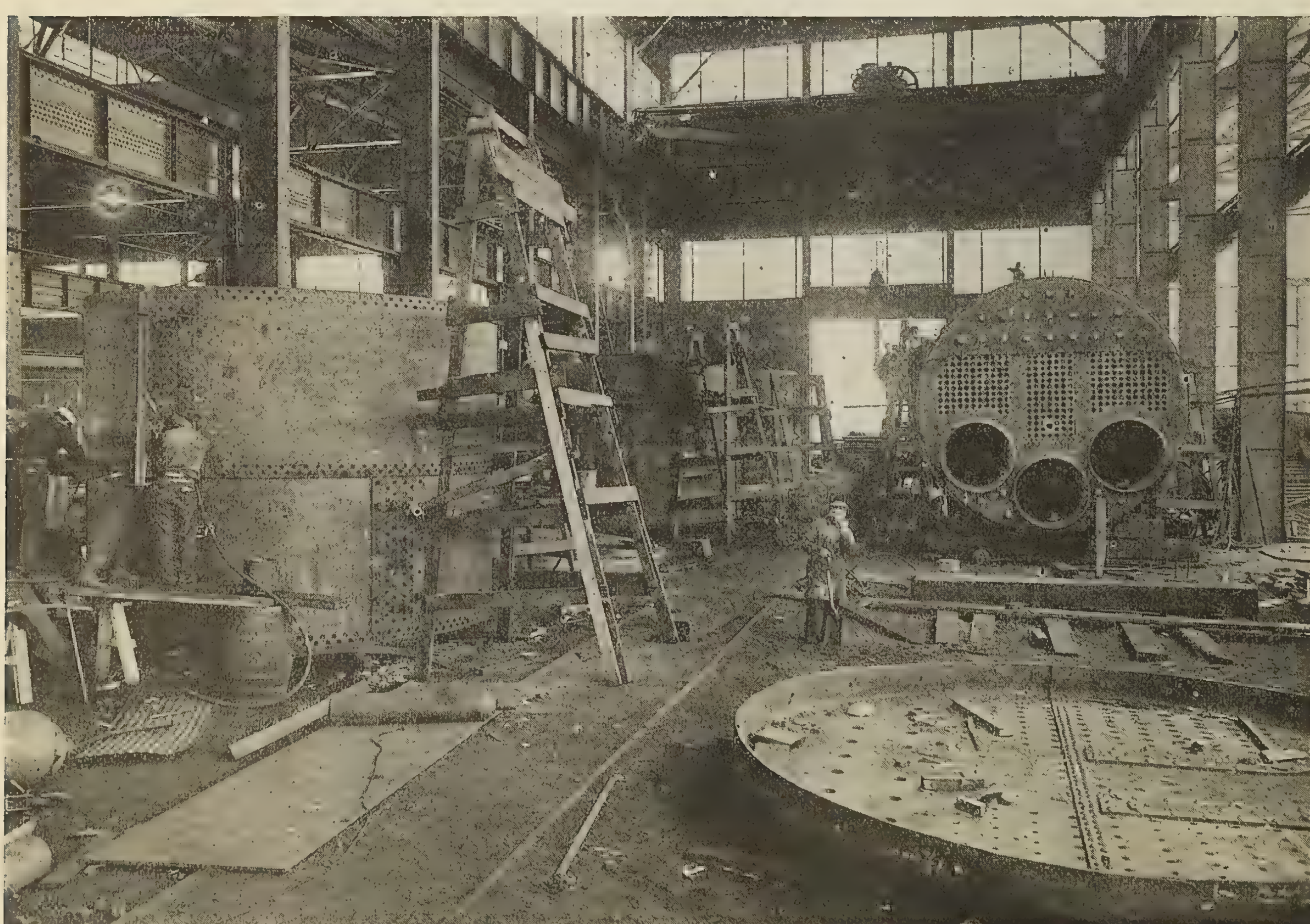

Fig. 10.—Another View of the Boiler Shop Showing Boiler in Course of Assembling

Fig. 11.—Angle Cutting Saw with Water Cooling Device in Operation

Fig. 12.—View of Interior of Ship's Hull with Frames Being Riveted

Fig. 13.—Exterior of Section of Standard Shipbuilding Corporation's Yard

their allotted tasks without loss of time, in that all working tools are kept in a shed immediately underneath the ways supporting the hull upon which the tools and the different gangs are engaged. Still a third is a sort of diagram, a blueprint, known as a "thermometer chart," copies of which are posted freely about the job and in the lofts and the shops to keep the men informed of the progress being made on each ship. Altogether, considerable detailed thought has evidently been expended generally toward holding production to maximum.

Where the Kaiser's "Meteor" Was Built

In a measure, Shooter's Island is famed as the yard where, some eighteen years ago, the keel was laid for the *Meteor,* a yacht built for the Kaiser. The spot is still there, of course; only now it is filled in in such a way that no ship will ever again be built on this unhallowed ground. To make this doubly certain, the ground is piled high with several thousand tons of plate, which effectively closes—or ought to close—Germanic performance in this country for all time.

The growth of the yard has been epochal. This is revealed in several ways. One is that on the first of the present year the number of workmen, both yard and office, lay in the neighborhood of three thousand, whereas to-day there are over forty-five hundred names on the books. Another is the sudden increased acreage. Fills have been made steadily from the beginning of the year, with the result that to-day a number of acres have been added to the available working space. One thing more. There are two ferryboats plying between the mainland and the yard to-day where before the present activity began there was only one ferryboat connecting the two points. And all this increased activity within a short twelve months!

There are no cross tracks on the island. All tracks lead radially from the shops to the ways or the water front. And that has its value. There is no stoppage confronting the locomotive cranes in their work, due to a blocked crossing, nor is there waiting one upon another of the locomotive cranes due to defective turn-tables or the laborious operation of these. Another thing, the yards throughout are served with electric trucks, rubber-tired, a number of which are fitted with cranes of particularly large capacity. Formerly, before the introduction of these, considerable material was transported about on flat trucks on rails, with laborers shoving the material along. This now, however, is completely done away with. The material is moved about with surprising speed, which is another important factor in holding the yard up to maximum output.

Size of Standard Ship

The Standard Shipbuilding Corporation, for a yard hurriedly whipped into shape for work of this capacity, presents an apparent efficiency that might be well worth taking pattern after on the part of other yards in the control of the Emergency Fleet Corporation. I say this with some reservation. One can't always tell, you know. Nevertheless, the standard ship itself, with a length of 392 feet 6 inches, a beam of 52 feet, with 7,500 deadweight tonnage, and making on an average of 10½ knots under a single triple-expansion engine operating with three boilers, each having three furnaces, is a unit of no mean proportion with which to grapple successfully in quantities. They are doing it here, however, and doing it to the satisfaction of the head of the Fleet Corporation, Charles M. Schwab.

The Heavy Oil Engine*—II

Relative Values of Oil—The Spray Diesel Valve—Ignition Conditions—Discussion of Structural Elements

BY CHARLES E. LUCKE†

THE heavier the oil the lower its vapor pressure or that of its heaviest constituent, then the hotter that mixture must be to be a gaseous mixture; and the hotter it is, according to this table, the lower the compression it can stand without self-igniting. Therefore, only those fuels that have high vapor pressures or that can make cold gaseous mixtures can be treated with the whole mass under compression. Those oils which are within the heavy class of oils, and have so low a vapor pressure as to require 300 degrees or 400 degrees initial temperature outside the engine plus a couple of hundred degrees rise in temperature coming into the cylinder, can be compressed hardly at all. Therefore, such heavy oil engines cannot by any possible conformity with Nature's laws be efficient. It is fundamentally sound that all those schemes for heavy oil engines that involve vaporizers are utterly incapable of producing an efficient engine.

For some reason or other everybody playing with this class of machine in the early days seems to have been absorbed with the idea of cooking the oil; they seemed to feel that it had to be roasted to death, and then wondered why they could not carry any compression, and why the efficiency was so low and the fuel consumption so high. This fundamental impossibility, against which mechanical ingenuity is absolutely helpless, never hit them at all; and that situation has lasted from the early seventies up till to-day, and people are still inventing schemes of this kind.

How to Get High Efficiency

It is perfectly clear that to produce a high efficiency, and at the same time a fairly high mean effective pressure in the interest of high power, the first and fundamental requirement is not only high compression, but to keep the oil away from the air until the time comes to burn it. By keeping the oil away from the air during compression, any compression you please is yours for the asking. It is purely a matter of mechanical clearance between the piston and cylinder head. Therefore, it would seem possible to secure almost any efficiency in such an engine with the delayed introduction of oil under the system which has received the name of late injections engines. Late injection is fundamental to efficiency.

Now the late injection principle of working is highly developed mechanically only in Diesel engines, and therein you see there is a little scientific engineering anomaly. The desired and necessary principle of high compression with delayed injection has been developed in its application to the less promising type of cycle—the Diesel; and the more promising type of cycle, the Otto—that which promises a given fuel consumption with half the compression of the Diesel—has been delayed, so that our engines have been highly developed along the less promising line without scarcely any development at all along the more promising line. Do you wonder, then, that with the success we have had with the less promising we may expect and look forward to much greater success with the more promising field when it is vigorously followed up?

* Paper read before the Engineers' Club of Philadelphia, January 29, 1918.

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We have come now to this point: That after compression we are to introduce the oil, and the oil may be introduced in such a way as to produce an explosion or to burn at substantially constant pressure without explosion. I want to point out to you next the controlling means in use for doing either one of those things or both of them.

The Diesel Engine

First, as to the Diesel. At the time the oil is introduced the temperature of the air is something higher than the ignition temperature—200 degrees, 300 degrees, 400 degrees or 500 degrees higher than ignition temperature—and so far in all these engines the oil has been introduced and sprayed by the aid of compressed air. How is the feed of oil controlled so that the rate of combustion shall be just enough to prevent the pressure falling along the re-expansion line, but kept substantially constant? That is entirely a matter of spray valve design. If you set yourself the problem, especially those of you who have not worked on this problem, of designing a scheme to squirt oil into a cylinder against 400 pounds or 500 pounds compression pressure at a graduated rate for 10 percent to 15 percent of the stroke, so as to hold the pressure constant, the oil burning as fast as it enters, you will find some little problem on your hands, and I venture to say that eight out of ten men will start with some kind of cam-driven pump. Now, that will not work at all. The thing that is relied upon is the tendency of the oil to stick to a metal plate. To make that clear, consider the ordinary spray Diesel valve with a fairly heavy stem in a casing. Beyond it there is a graduated orifice outlet, which is the spray orifice and is changeable in size to suit the viscosity of the oil. The oil is pumped into the chamber or space between the casing and the valve stem by a pump which has only one duty to perform, and that is, measure the amount, not time or graduate of the injection. That cannot be done, or it never has been done. I do not think it can be done. The oil, in the ordinary course of events, is put into the spray valve chamber before the injection is wanted, and it will run down to the bottom more or less fast. If the valve be lifted and the oil itself has reached the bottom or valve seat, the first thing to happen after the opening of the valve is a squirt of solid oil with no spraying whatever. In an instant the oil is all out, and, instead of maintaining a graduated combustion for 15 percent of the stroke, we have a lump of oil squirted in without spraying or graduation. There will be a certain amount of combustion, but only part will burn; the rest makes a little lump of carbon.

Action of Oil in Chamber

Now, to secure graduation of oil feed, all that has been done is to stick a lot of plates with holes in them in the space between valve stem and casing. These plates have definite thickness spacing and drilling; sometimes they are given special forms and surface finish, each designer adopting an air of great mystery about his arrangement and claiming absurd superiority over his rivals.

All that these things do in the oil chamber is to provide an extended surface to which the oil naturally tends

to stick. It might be filled with shot and it would no doubt work just the same. The oil is pumped into this chamber, and when the valve is pulled open the oil tends to travel down, partly by gravity and partly by the surface frictional influence of the air on the oil. The oil, however, is sticking to that labyrinth surface. The oil chamber is nothing but a mechanical labyrinth. That is what it is called for want of a better name. And that is the only means that works as a graduator of oil feed, except one. The other one surrounds the valve stem by a sort of Venturi tube casing, between which and the valve body is found the oil receiving chamber. There are two holes in the Venturi partition between the oil chamber and stem chamber—one from the Venturi throat to the bottom of the oil, the other imposing the total air pressure on the oil surface. When the valve is open the compressed air flowing through impinges on that hole to the surface of the oil and builds up its total pressure, while at the same time the other hole, being at the throat of the Venturi, is subjected to a lesser pressure by the air velocity head, thus developing lifting tendency on the oil, and we have a regular vacuum flow injector. This action of the former one of the labyrinth forms the basis of all the schemes for graduations of feed of oil from the spray valve body to the spray valve nozzle, so that the oil feeds during the required period of time at a more or less steady rate to this nozzle, and it is torn to pieces or sprayed by the velocity of the air issuing from it. It is clear that with this arrangement the rate of oil flow, the time of oil feed, and the rate of combustion will vary with the viscosity of the oil.

Discussion of Explosive Mixture

Should such a valve be adjusted by the spaces and orifice size to give the required feed for a given oil, and then supply an oil of lesser viscosity, or maybe the same oil supplied hotter, or really a less viscous oil, then it will discharge much more rapidly, and instead of a horizontal combustion line there will be a rapid rise of pressure somewhat like a slow explosion. This indicates what is necessary if we desire to make a spray nozzle suitable for producing an explosion. To produce the explosive mixture and secure explosive combustion of oil with the spray nozzle, the first step necessary is to reduce the flow resistance in the body of the nozzle by removing a considerable amount of the labyrinth surfaces or by reducing the viscosity of the oil by heating it. As a result the oil will be discharged much more rapidly, and if enough resistance be removed from such a spray nozzle it would give a substantially instantaneous injection of oil as a liquid spray. If that occurred we would have a more or less finely divided spray scattered through the mass of compressed air, and if the air is not up to ignition temperature then we would have produced what might be called a liquid explosive mixture, ready for any kind of ignition that is handy. It is a liquid explosive mixture because no attempt has been made to vaporize the oil. All that has been done is to make really fine fog of liquid drops suspended in the air, scattered through the combustion chamber. To get such an explosive mixture or charge ready for ignition it is necessary that no part of the interior walls or the air itself touched by the oil be up to ignition temperature, because if the air should be up to ignition temperature, as would be the case with the Diesel, then the oil would ignite as it came in, before the oil spray charge was scattered through the air. To obtain the explosion it is necessary to get all the fuel into the cylinder and scattered through the air before it is ignited, just as with delayed electric ignition. On the more desirable Otto cycle with its explosion it is necessary to prevent the air reaching ignition temperature during compression; it must be capable of igniting the oil, and the ignition, by whatever means is relied upon, must itself be delayed long enough to let the whole charge of oil get in the cylinder, because unless it is in there is nothing that can explode.

Now as to igniters. The common thing has been a hot plate; sometimes a bulb of spherical form with a neck; sometimes a hemispherical bulb without any neck, just forming a cylinder head, and sometimes all sorts of weird curves and twists and shapes—every one of them the subject of a patent. Now, of that collection, what is good and what is bad? There is a simple way of sizing it up. The hot metal—that is, the igniter—must be so related in position to the injection point that no part of the oil reaches the hot plate before all of it is in the cylinder, and the shape such that no part of the oil reaches the hot plate before any other part.

What Happens in Combustion Chamber

Let me illustrate and you will see the force of this principle. Consider a cylinder with a spray valve at one edge of a nice hemispherical plate, red hot, the oil being sprayed at an angle toward the plate. There have been many made like that. The hot plate comes up quite close to the injector, which discharges a more or less conical spray. Some of the oil will strike the hot plate before the oil is all in the cylinder, and considerable of the air. The first oil that hits that plate is going to fire the charge, or so much as has entered, and much of the air is utterly inactive and cannot do anything, as it has received no oil. At the same time, an explosion of part of the charge has taken place and the rest is still coming in. What does it meet on the way in? A red hot—yes, a white hot—mass of inert gas. What will happen? Nothing but crack, liberating free carbon and carbon monoxide. The unused and unmixed air leaves free oxygen in the exhaust, and with it the unburned fuel appears as carbon monoxide and much free carbon with plenty of solid carbon cake inside. A very low mean effective pressure and low efficiency will result, and the engine will be very dirty.

Attainment of Ideal Conditions

The ideal condition is that in which no part of the oil strikes the igniter sooner than any other part, and none of the oil strikes the hot plate until all the oil is in. Now, what kind of arrangement would give that? Suppose we had a spray valve making a cone-like spray discharging axially in a hemispherical head, the center of which is the spray orifice. Then at the time the oil at full load had reached this hot ignition plate the last oil would have come in if the dimensions were right. That would be in conformity with the principle laid down. That arrangement will give anywhere from 50 percent to 100 percent more mean effective pressure than the non-symmetrical arrangement previously described, and with it any compression you please may be carried. It does not matter how hot that latter plates gets, whereas the former has to be run cool on the side where the oil first strikes, and yet hot enough elsewhere not to miss fire. At full load it tends to get too hot and pre-ignite and knock its head off; with a light load it fails to get hot and fails to fire at all. And so the engines in that class are always provided with some kind of scheme to prevent their getting too hot at heavy load and too cold at low load. The popular water injection scheme usually does nothing but wash the lubricating oil off the cylinder wall.

For a long time, practically throughout the whole history of this art, this condition of necessary relation be-

tween the spray valve and the hot plate igniter has not been realized, and yet hot plate igniters have been in almost universal use. Now, hot plate igniters themselves are a bar to progress, because if we use a hot plate igniter it has to be an outer wall. It has to be an outer wall so that you can start it with a torch and still not burn up. An inner wall cannot be started. A hot plate submerged in a cylinder cannot be started, because you cannot get a torch at it from the outside. If a hot tube igniter be provided for starting and an internal plate relied upon for running, as is sometimes done, then you have no control over that hot plate at all and it will burn out. So a hot plate igniter has to be an outer wall to be practical, and when you have made it an outer wall to be practical, then it is not really practical, because it limits the size. That red hot plate lacks tensile strength.

Structural Debarment to Ignition

A cast iron can be found that will not lose too much tensile strength, but, nevertheless, it is very weak in proportion to what it might be. As cylinder sizes go up—and I have already indicated that one of the great fields of need for the heavy oil engine is ship work, which calls for cylinders to go up just as high as we can make then go—then the external hot plate is barred. It is not good because it is too weak structurally. Here is the place then where the functional problem leads to a structural debarment and where progress into the larger sizes requires an abandonment of the red hot plate as an igniter. Men have tried various other schemes, and there is now being attained some success with electric igniters and with moderately warmed internal hot plates, which are more properly called "warm" plates. Suppose, with reference to the latter, that we have a 300-degree internal temperature and one that would stop just short of ignition. Suppose we had a 300-degree initial temperature. Then for practical reasons about 279 pounds compression would carry the entire air above ignition temperature approximately 200 degrees, and that would not be practical with late injection. If, however, the initial temperature of the air were lower, or a sufficiently lower compression were selected, we could come within 100 degrees or 200 degrees of ignition temperature and still have a very substantial compression. As a matter of fact, it is perfectly feasible to use compression up to 175 pounds, approaching 200 pounds—possibly more—without reaching ignition temperature, provided the initial air is not too warm. Suppose we were injecting straight toward the piston and we had a spot of metal on there that did not get red hot, but raised the temperature of the air right next to it 200 degrees or 300 degrees higher than elsewhere. That is all that is necessary for ignition, and that is one way the thing might be done—a cold external wall for strength, a warm internal spot at the maximum distance from the igniter, not red hot but sufficiently warm to supply a couple of hundred degrees difference between the temperature attained by compression (which is not high enough to produce ignition) and the amount necessary to actually produce ignition at that one spot alone.

We do not know much as yet about that scheme, except that it is possible to run that way. Whether it can be developed into a practical controllable thing remains to be seen. I am inclined to think it can. If it can, then one serious bar to the increase in size and more extended use of the Otto cycle engine has been removed and a new field of most interesting and valuable possibilities opened up.

Without that, however, there is still another way of proceeding that is receiving some attention. For a long time back is has been known that with a sufficiently fine and proper kind of spray of oil into air an ordinary spark plug would serve as an igniter. With the wrong kind of spray and plug the oil would collect at the spark plug and short circuit it, but a spark plug can be made to ignite the right kind of spray just as positively as it ignites a gaseous mixture. An apparatus involving the lighting of sprays by spark plugs is going to receive considerable impetus in the near future.

A Suppositious Case and the Diesel

As to engine schemes, suppose we had a thoroughly cold interior engine—an engine the walls of which were all cold, just as cold as we can get them, and to my mind you cannot get them cold enough for a good practical oil engine—the colder the better. Into that cold cylinder we admit a charge of air and compress it, but not sufficiently to produce ignition, and when we get a sufficient compression to produce a highly economical engine as to oil and sufficient to produce a mean effective pressure approaching 100 pounds per square inch, then ignite with this spark plug. That can be done, and it is a most interesting possibility. It is particularly interesting because in conjunction with it, it is possible to use a modified oil spray.

With the standard Diesel engine the oil spray valves is supplied with compressed air under 1,000 pounds and more. Now, in the actual running of these engines the air compressor to supply that air and the air storage are just about as big a nuisance as the engine—sometimes, and often, in fact, more. If we could get rid of that it would be a splendid thing to do. A "solid" spray is therefore a highly desirable thing.

The Navy Fuel Oil Burning Spray

So far we have succeeded in making a number of engine solid spray valves that work quite well, and they work so well that I feel confident that the end of the compressed air spray is drawing near, and that thereby we are going to eliminate another big source of trouble. I am not sure that the solid injection spray I have in mind will work on the Diesel engine, because the Diesel engine requires a graduated feed, and I am not at all sure that the principle of action of the solid spray can be adapted to the graduated feed. It works splendidly with the instantaneous feed for the Otto cycle or explosion engine. There is only one principle that need be kept in mind to explain the many ways of working out the solid spray, and that principle is pretty old. It is the principle of the navy fuel oil-burning spray for boilers. The navy and other ships cannot afford to use compressed air or steam for spraying oil, as is so common on land, because they have not the fresh water with which to produce this steam. They are, therefore, compelled to use a mechanical spray, and this type of spray has been very highly developed. It involves nothing more than a minute orifice from which the oil is discharged with a combined motion axially through the hole and rotary as it comes out, the rotary motion being developed before the oil reaches the hole in a rifling tube or tangential feed passage to a little whirl chamber just back of the spray orifice. By giving the oil a whirl behind the spray orifice with a proper exit from the orifice it issues with a motion in two directions—axial and rotary—producing a sort of solid conical spray that is fine and works well in an engine. By making the passages small enough in such a spray valve so that they are practically capillary, then a direct-acting pump plunger slamming against the solid column of oil will make such a spray without any dribble at the ends of the spray period. Re-

member that no dribble at the end or beginning of a spray is permissible, because every drop that dribbles carbonizes. To avoid the dribble the only thing necessary is to get the passages substantially capillary in size, and that is not difficult. At first glance it would seem as if that boiler spray valve could not be made to work with rapid intermittence; but it can, and is so working to-day.

Matters Concerning the Structural Elements

Now a word or two on the structural side. We may assume that this functional question has in it considerable undeveloped possibilities, and that these are not mysteries, but are lines of purely rational progress, the key to which we have in every instance, and nothing is unknown except how far you can go. We know the route every time; but we do not know how far we can go. Assuming that you can see with me in your mind's eye non-Diesel, late injection, high efficiency oil engines working as well as the Diesel, or better, then arises the question: How should the structure be built? Are there any lines of standardization that can be well and properly applied there? Or is every designer to regard himself as the one selected by the Almighty to produce something that no one else ever made? For some strange reason, that seems to be in the minds of almost all oil engine designers. While for years we have been building shafts, frames and engine structures for steam engines and similar structures for pumps and compressors, just as soon as an oil engine designer gets his hand over a drawing board he wants to throw all that experience away and get up some other thing and make more trouble than do the parts that are peculiar to the oil engine.

The point of view to take with regard to this structure is this: There is no essential difference in kind, except the cooling problem, between an oil engine cylinder and a steam engine cylinder. The difference is one of degree in the structural problem. There is no essential difference —certainly none in kind—between the problem of the frame and the bedplate and the rest of the running gear of the oil as compared with the steam engine. That being the case, these queer arrangements that have crept into the oil engine field and that have become more or less standard there, quite contradicting all previous experience and established custom with the more firmly established steam engine, cannot be accepted. There is no difference whatever in the design of a column to support a bridge, a pier, or a building, or to support a statue; all that counts is the load to be placed on it. And yet the oil man has persisted in carrying out his structure from cylinder down to bedplate on radically different lines than have long been standard with steam. The result is hopelessly bad. Let us bring out some of our good old designers who understand the designing and building of structures to carry loads, and I would not tell them anything about the oil engine peculiarities at all. Some other man is taking care of that. Then we will get somewhere.

Stresses in the Cylinder Castings

Just to point out one or two things to illustrate what I have in mind, consider the most widely used Diesel cast frame structure extending from bedplate to cylinder head, and being an axially expanding cylinder line. This cylinder line is a stressed member, the stress being bursting stress, with 400 pounds or 500 pounds per square inch normal pressure at the top, and possibly an accidental maximum pressure with a pre-ignition pressure of twice that amount—1,000 pounds or 1,200 pounds per square inch. Now we certainly know how to build cylinders to withstand bursting, so this is not peculiarly an oil engine problem, except that its expansion must not be restrained. That cylinder structure is inside of a heavy casting and held at the top. This casting is practically an "A" frame with a cylindrical extension at the top; the cylindrical extension forms the water jacket and is faced at the top, on which the cylinder line flange rests. There is a slip joint at the other end of the line to allow of longitudinal expansion of the cylinder line barrel with reference to the jacketed frame. An engine built along such lines as that is fundamentally wrong, because the jacket is at the same time a frame. What is its principal duty? Its principal duty is to hold water—and anything that will hold water will do just as well—and yet you will find big engines with jacket walls of 1¼-inch cast iron for many feet in diameter. Think of all the weight that goes with that, and for what? To hold water and transmit an upward tension load from the cylinder head down to the main bearing. Nothing could be more fundamentally wrong. In the first place, as to the material, it is all cast iron and is always in tension if it is loaded at all. If it were a steam engine there would be an alternate compression and tension; but here it is tension-loaded, and if there is any worse material than cast iron for carrying a tension load, it is probably cast aluminum. Furthermore, if such a cylinder line barrel is strong enough to resist bursting, it has just twice the factor of safety for the longitudinal tension stress, which means that the double metal of line and jacket is entirely unjustified. The cylinder should be held to the frame at its crank end and the jacket eliminated as a stressed member. There is no reason for carrying a heavy cast iron wall for a jacket, when ordinary tank steel will do the job just as well and a little bit better. We have oxygen welding apparatus that will enable us to weld the edges of a thin sheet to cast iron with perfect success and with not much expense.

Paralleling with Standard Steam Practice

There is then a necessity for changing the cylinder to take off that unnecessary weight. Do you know that some of these engines of stationary form—the class I am condemning—weigh 600 pounds per horsepower? Think of it! And when these same engines are refined down for ship work without changing the type of structure, just the same typical arrangement, but reducing the bedplate and getting rid of flywheels, they come down to about 150 pounds per horsepower. But there they stick. To go below that it is necessary to change the structural arrangement to conform more and more nearly to the better and more refined class of standard steam practice, and in this country there are excellent models for them, and all that has to be done is to follow them out and keep within the same method of calculating loads and factors of safety—keep the same factors and the result will work just as well as in the steel. That means not only the taking away of this cast jacket and making the cylinder barrel carry the two kinds of stress—the bursting and the longitudinal at the same time, which it is perfectly able to do—but it means also to take this heavy cast iron frame structure away from the space between the cylinder end and the bedplate and to substitute for it the steel tension rod construction of the torpedo boat or yacht engine—to mention the two most highly developed forms of that structure. To be sure, that type of engine is not a stiff engine. Certainly the cylinders are going to sway and weave. But what of that? Where did these oil engine designers get the idea that this thing had to be a stiff structure, like a brick wall? I do not know where, but they got it, and there it sticks.

The most successful engines we have to-day, and the

most wonderful machines that we have ever designed, are steam locomotives. When you consider what they have to do and how well they do it, they are truly wonderful. What would happen to a locomotive that was built stiff? And what would happen to the rails on which it runs? You would have neither locomotive nor rails at the end of the first run. The steam engine that gives years and years of service and is regarded as a model of reliability, carrying a ship trip after trip back and forth across the ocean like a ferryboat, is that a stiff structure? It is not; it weaves and twists, but that does not hurt it. Why, then, should we insist upon the cast iron stiff structure for oil engines? There is no reason on earth why we should. So I say that we can take the steam engine structure from bedplate to cylinder and design and apply it to oil engines, selecting dimensions to give similar elastic factors, bearing loads and so forth, and it should give equal success.

Troubles in the Foundry

After these two changes, it will be time to remove the outside cast wall of the cylinder head. By taking the cast head jacket away from the top of the head we will free the valve housings, the intake and exhaust ports, the housing for spray valve and starting valve. These will then be exposed and the present elaborately cored casting eliminated. These cored heads are so awful the foundrymen and molders are not to be blamed for doing with them what they always do when they get into a corner with cores that are too intricate—they knock a piece off; and then we wonder why the head overheats. The designer thought he had provided for water, but the molder could not get it there, and the designer is responsible for asking a molder to do what no man could do. In proportion as that casting is made easy to mold, so it will be a good job. By means of the oxygen weld the whole cylinder head top can be left off and the only cores left are the cores for the intake and exhaust, which are easy cores. Then you get a clean casting which can be inspected on both sides and free of bad shrinkage stresses, add a sheet jacket welded around the edges and you will have a real job.

Pre-eminence of Submarine Engine

Just as an indication of what happens when this thing is carried out, even in part, I will tell you that the most highly developed of these oil engines to-day are the submarine engines. In those engines the heavy cast frame structure in the better of them has been removed, and, as a consequence of the steam engine practice as to frame structure, those engines, which in the older form of oil engine structure weighed 150 pounds, more or less, to the horsepower, have come down to what? Thirty-five pounds or 40 pounds per horsepower. They still, however, are carrying the cast iron jacket and a cast iron roof to the head, so there is room for saving some more without doing any harm whatever.

To conclude, then, with a word or two about the auxiliaries, especially with ships, because you may get a perfectly fine engine, and by wrong kinds of auxiliaries or wrong arrangement of auxiliaries have an awful hard engine room to work. The tendency for some time has been to regard the engine structure, when it comes to auxiliaries, as a sort of Christmas tree, on which you hang anything you want to use. If they decided to put a fire alarm in the engine room, I have no doubt that they would stick it on the engine somewhere. You find circulating pumps, air compressors, water pumps for circulating water, and oil pumps—in some cases bilge pumps—all hooked onto the main structure of the engine, which, in some cases and quite a number, is 2-cycle, with a row of scavenging cylinders stuck along one side, so that they resemble the old river boat engines. It certainly makes a weird combination, and in the old-day steam engine practice just that thing was done. They carried feed pumps on the engine, condensers were mounted on the engine, and hot well and circulating pumps likewise. It took us 150 years to get rid of that arrangement, and it is no longer standard practice. The engine structure should be preserved and respected as an engine structure, and not interfered with at all by hanging any kind of trimmings on it that have the slightest possibility of interfering with access to the engine. Doubly so is that true when the auxiliary attached to the engine does not and cannot behave right as attached.

Separate Control for Engine and Cooling Water

In the latter connection, I would call your attention particularly to the circulating pump for water. When the circulating pump for water is driven off the engine, either by its own crank or by rocker and links from other moving parts, then when the engine stops the water stops, and when the engine starts the water starts. That might seem to be a desirable thing at first glance. As a matter of fact, it is positively dangerous, and many cracked cylinders and piston heads can be traced to that cause alone; because, consider the interior of a cylinder when the engine is running at full power, and you will see that there are some hundred pounds of metal very hot—quite hot in proportion as it is thick. Now, when that engine is shut down, heat is there as insensible heat of the metal, and the jackets are full of water—X pound of water and Y pound of hot metal. If the weights and heats involved are figured out you will find in a big engine there is enough heat in the metal to evaporate all the water to steam and you would still have some left to conduct out to more distant parts, which should be cold—parts which are designed to be cold, but which, when hot, crack. Especially is that true when, after such a shutdown and a general heating, somebody starts the engine and shuts a lot of cold water up against the surface. That condition can be eliminated only by completely independent jacket water circulators separately driven by another engine, which permit the running of the water so long as water comes out from the discharge with any rise in temperature over the intake. In other words, the water should be continued through such an engine until it ceases to become warm, and that may be from twenty minutes to half an hour after the shutdown, depending on the size and style of machine.

A similar discussion could be carried on about other auxiliaries. This question of auxiliary arrangement and starting by an auxiliary engine is just as important for study as the engine itself. There is just as much room for improvement as in the engine structure, as a structure, or the engine parts that are concerned with its functional operation.

Getting back now to the beginning, it must be admitted, and the more you study it the more willing you will be to admit it, that, while we have made very considerable progress with the heavy oil engine, that progress is by no means ended. In fact, we can go much further yet than we have already gone, and we can make the heavy oil engine meet conditions it has heretofore failed to meet.

Shipyards allotment of 250,000 tons of steel monthly is to be reduced to 150,000 tons a month on January 1, owing to their accumulation of 1,300,000 tons of reserve stock at the yards, enough for 4,000,000 tons of shipping.

Rapid Development of the Electric Cast Steel Anchor Chain Industry*

Immediate Needs for Chain—Early Difficulties Seemed Simple—Electric Welding Versus Hand Welding—Tests and Results

BY W. L. MERRILL

AT the time our shipping programme was decided upon, it was obvious that the United States was in no position to furnish many of the items entering into the construction of ships. One item was anchor chain. The average size merchant ship requires in the neighborhood of 30 tons of anchor chain, and for a programme of 1,500 ships this item alone would run to approximately 45,000 tons of chain or over five 8,000-ton shiploads of chain. To this equipment had to be added the complement of anchors and wild cats, together with the necessary storage facilities. This in itself was no small part of the ship programme.

The anchor chain industry has for the most part been limited to foreign manufacture, as the amount of merchant marine built in recent years in this country has been practically negligible. Our navy, however, manufactured most of its chain at the Charleston Navy Yard; but as the time for building a battleship varies from three to five years it is obvious that the anchor chain could readily be produced during the interval between the time the keel is laid and the time the chain is required, since comparatively few ships have been under construction at the same time, and a ship requires not much chain.

The universal method of making chain, with one or two exceptions, has been by hand forging; and a gang of chain makers could produce but a few links each day. It therefore seemed inevitable that a new process for making anchor chain must be developed or a great army of workmen would have to be trained and facilities supplied for producing chain by the original methods.

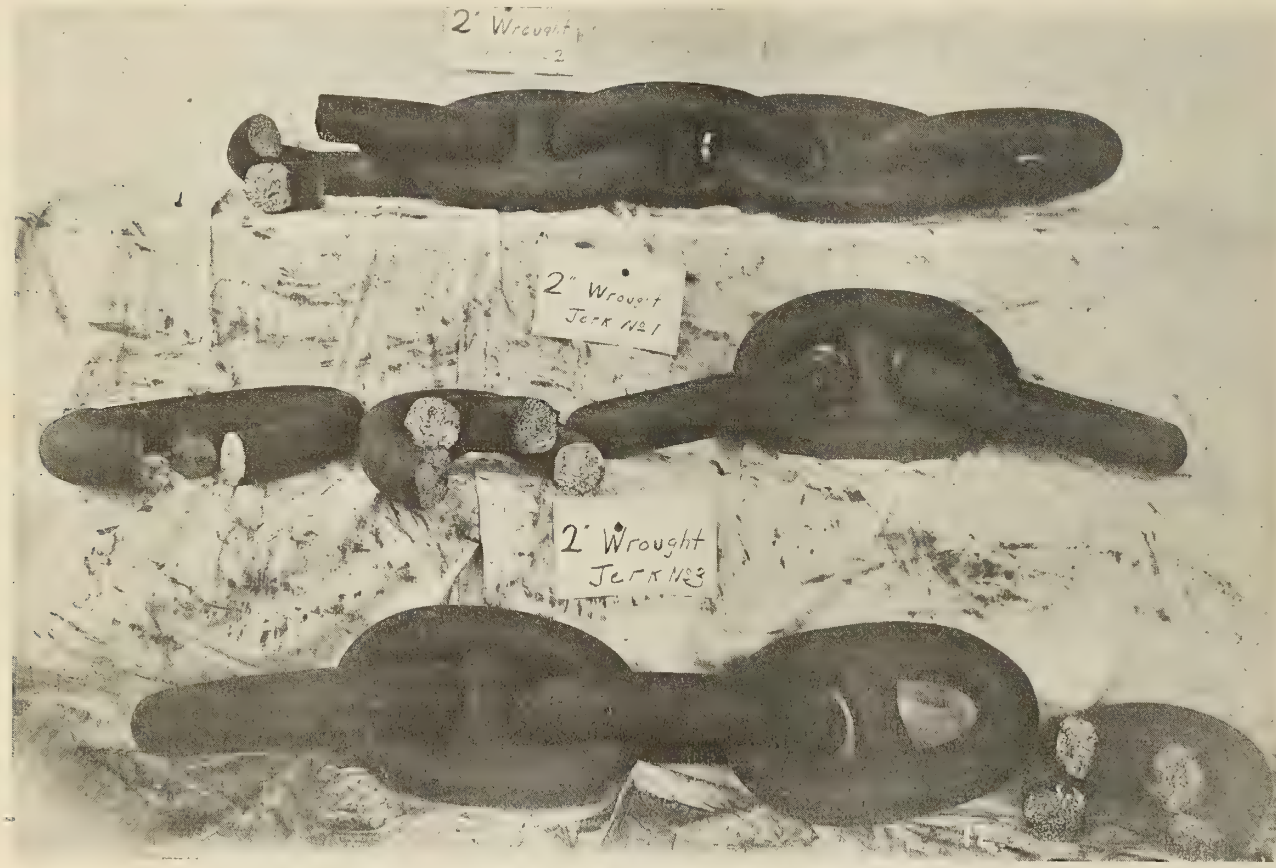

Fig. 1.—Results of Jerk Test on 2-Inch Wrought Iron Chain

To solve this dilemma, the Shipping Board appealed to the Engineering Committee of the Council of National Defense to investigate and advise the most economical method of producing anchor chain in large quantities. Accordingly, a sub-committee was appointed consisting of representatives of chain manufacturers, Navy Department, classification societies, United States Steamboat Inspection Service, and the Emergency Fleet Corporation, with the writer as chairman.

From the standpoint of an electrical engineer the problem seemed simple, as evidently the principal duty of an anchor chain was to connect an anchor at the bottom of the ocean with the bow of a ship and to have sufficient strength to keep the two in fairly close proximity to each

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*Abstract of article published in *General Electric Review.*

other during storms and shore leaves of the crew when in friendly ports. However, the factor of strength did not prove to be of primary importance when considered from the nautical viewpoint. The weight of chain per fathom for a given size ship was the important requirement, and this is obvious when the action of the chain with the ship riding at anchor in a heavy seaway is considered. Assume, for instance, that it is possible to have a thin wire of a strength equal to that of the anchor chain for a certain ship; it is evident that when the ship heads into the wind with the bow in the trough of the sea the next wave coming will raise the ship, which action will result in the wire breaking or dragging the anchor. Therefore, it will be seen that weight per fathom of chain is a very important factor, and investigation has shown that chain of sufficient weight for a given ship will, if properly made of a good material, have sufficient strength.

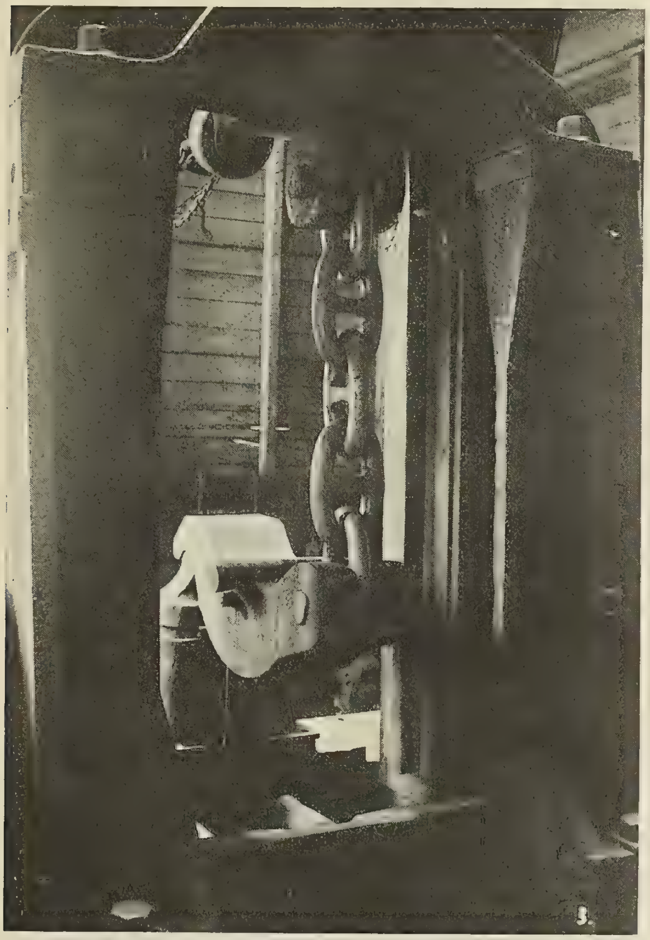

Fig. 2.—Chain Subjected to Jerk Test

One of the first investigations carried on by the committee was to consider the substitution of electric welding for hand welding of chain. This was successfully done. However, as in the hand process of welding and in the machine forging process, as used at the Charleston Navy Yard, it simply speeded up but one of a number of operations necessary to produce the chain.

It was then decided that, whatever be the process of welding the chain, at least every other link could be drop-forged to shape, including the stud, and the alternate link could be welded by hand, machine or electrically. A set of dies for 2-inch chain was accordingly made at the Schenectady works of the General Electric Company and a number of links were forged. Tests showed them to be successful. It was thought that the Fleet Corporation would be able to obtain drop hammers in various parts of the country, order links forged from cast ingots and have the links shipped to chain shops, where they could be welded in the finished chain, thereby materially reducing the labor on half of the production. This method would not particularly adapt itself to the heavier chains, as it is much easier for a chain maker to weld a link at the end of a chain than to connect two pieces of chain together; and, while it would have undoubtedly speeded up the production of chain, on the whole it would have handicapped that part of the process in which hand welding would be employed.

From the foregoing it appeared that any process for making chain which would make a real reduction in the over-all labor must be some radical change from the conventional methods, particularly eliminating the preparation of the material for the chain, the hand method requiring—starting with pig iron—melting down, puddling, squeezing, rolling ingots into bars, cutting bars, bending links, scarfing for the welds, welding, inserting stud.

For each operation in bringing the link to shape, repeated heating is necessary. It appeared that to turn out the amount of chain required by the Shipping Board in the time estimated the hand method would have required more man-hours and weight of equipment to produce the furnaces, machinery, etc., than it would to produce the chain itself.

In 1911 the Marion Steam Shovel Company had occasion to build some chain for dredge work, the links being 36 inches long and the wire 7½ inches in diameter. This was made by casting one link at a time with the molds interlocked. This chain was entirely successful and is in service to-day. It occurred to the writer that it might be possible to cast much smaller chain than this by the use of electric steel. Accordingly, samples were made in the Schenectady works which proved that successful chain could be made by this process. The first attempt was made by die-casting the links, with the studs afterwards placed in position, the same as in hand welded chain. It was found, however, that while it was possible to make die-cast chain from electric steel it was not feasible for a large production, since there is a very critical time at which the molds should be opened to prevent shrinkage cracks; and if opened too soon, the metal, of course, would not be

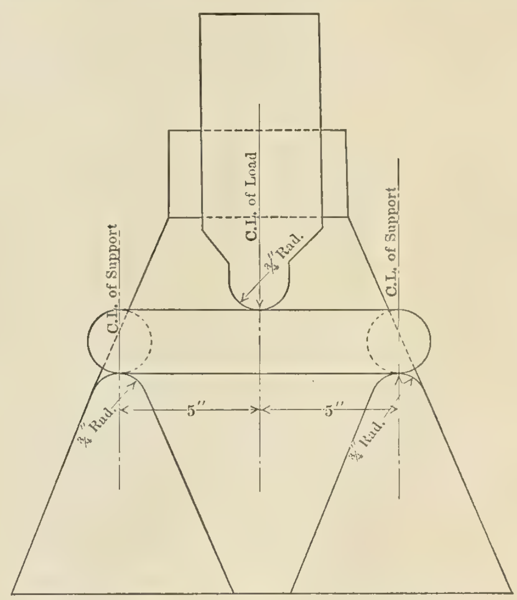

Fig. 3.—Transverse Bending Test

congealed. Therefore, dry sand molds were resorted to and successful chain was made by this method.

The classification societies' requirements for 2-inch chain are as follows:

Breaking test....................225,792 pounds
Proof test.......................161,280 pounds

It was decided at this time to extend the activities of this investigation and methods of casting. Consequently, the National Malleable Castings Company was interested in

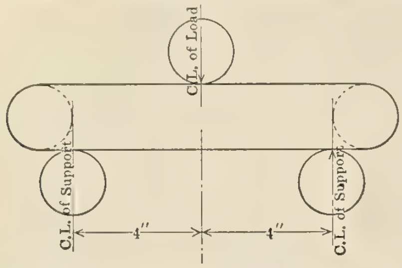

Fig. 4.—Showing Diameters of Load and of Support Bearings

making sample electric steel chain. The E. H. Mumford Company was asked to investigate automatic machinery for producing molds. Those companies worked up a process for molding chain in sections complete with the studs cast as a part of the link, and successful chain was made by this process in several foundries. The National Malleable Castings Company then made chain in various sizes from 1⅜ inches to 2⅞ inches, the 1⅜-inch link apparently being the smallest that it is at present practicable to mold. Tests were then carried on at their plant with various samples of chain which they had cast, in comparison with hand-wrought chain and navy chain from the Charleston Navy Yard. These tests consisted of tensile tests and shock tests in a standard MCB machine. In all cases the electric steel chain showed greater tensile strength and stood more punishment in the drop test than the wrought chain.

Further tests were made at the National Malleable Casting Company's plant to get comparative data and specifications on a shock bending test.

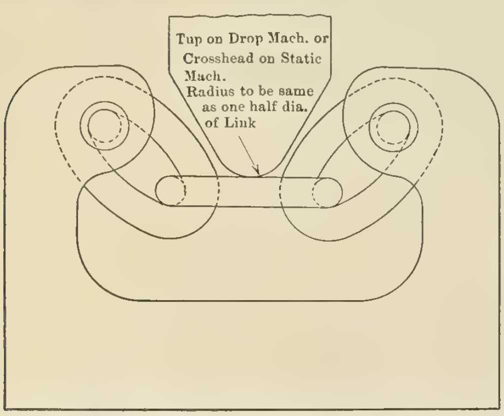

Fig. 5.—Diagram Showing Chain Support

There are no requirements for elongation or reduction in area. Our first samples tested at the Bureau of Standards were nearly double the strength of wrought chain, and it was felt by some members of the committee that this was the solution of the chain problem. Other members felt that further tests would be necessary before adopting cast steel chain, and seemed to be much exercised about the comparative corrodible quality of electric steel and wrought iron. But, there being no reliable data available on wrought chain, it was felt that the life of electric steel chain in comparison would at least last during the present emergency, and therefore the question of corrosion was dismissed. Nor was it again brought up for consideration.

As a result of this work, the American Bureau of Shipping and Lloyds have approved and issued specifications permitting the use of electric steel anchor chain on ship-

Fig. 6.—Results of Static Test

Fig. 7.—Machine for Making Static Test

board, these specifications differing in the main from those for wrought chain in the following points:

The original breaking test of wrought chain is now specified for the proof test with proportional increase in tests for sample links above this of 40 percent. For example, the original proof tests of 2-inch chain, 161,280 pounds; for electric steel, 225,972 pounds. The original breaking test for wrought chain, 225,792 pounds; for cast steel, 316,109 pounds. To this is added a shock bending test for sample links as mentioned above.

How the Tests Were Conducted

When we consider the method of making anchor chain a year ago and follow the ore from the mine to the finished product and compare it with the electric steel method, we must realize that, first, better chain can be produced; second, tremendous economy can be secured in the conservation of man-hours, machinery, fuel, and transportation. The conservative estimate of a foundry equipped with an open hearth for melting down and a 10-ton electric furnace for refining should produce 70 tons of finished chain each 24 hours, based on a 2-inch average size. Practically no skilled labor is required, outside of that for supervision.

The tests which follow were conducted in a static test machine of 1,000,000 pounds capacity and a standard master car builder's drop test machine.

Two kinds of tests were made in the static machine. The first consisted of supporting separate 2-inch links on 2-inch round pins spaced 8 inches from center to center. A third 2-inch round pin was placed transversely across the link at its center and the load applied on this link.

The second test consisted of supporting a 2-inch chain consisting of three common "A" links in a frame and applying the static load at the center of the middle link.

Two kinds of tests were also conducted in the drop test machine. The first kind consisted of supporting a 2-inch chain consisting of five common "A" links in a vertical position by supporting the upper link in a shackle bar and the lower link in an equalizer bar by means of shackle pins and in such a manner that one-half the energy developed from the falling tup will be imposed upon the chain thus suspended and in the form of a dynamic jerk.

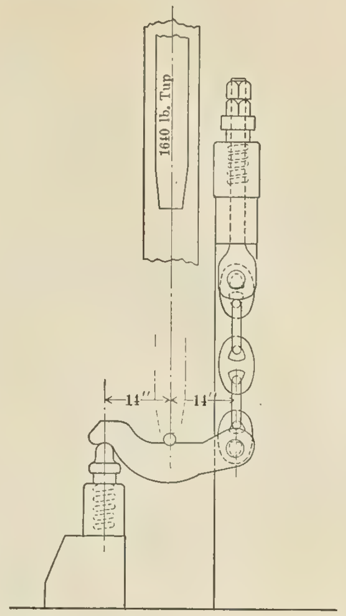

Fig. 9.—Diagram of Jerk Test Machine

The second kind of drop test was conducted on separate common "A" links by supporting the link in a standard MCB knuckle pin test block. In this case the supports were ¾-inch radius and 10 inches center to center and the dynamic load was applied transversely at the center of the link, through a plunger having a ¾-inch radius at its nose.

For convenience, we will classify these various tests into groups, according to the kind of test made. Group No. 1 will embody the transverse tests conducted on separate common "A" links in the static test machine. Test group No. 2 will embody the tests conducted on the three-link chain in the static test machine. Test group No. 3 will embody the transverse tests conducted on separate links in the drop test machine. Test group No. 4 will embody tests conducted on five-link chains in the drop test machine.

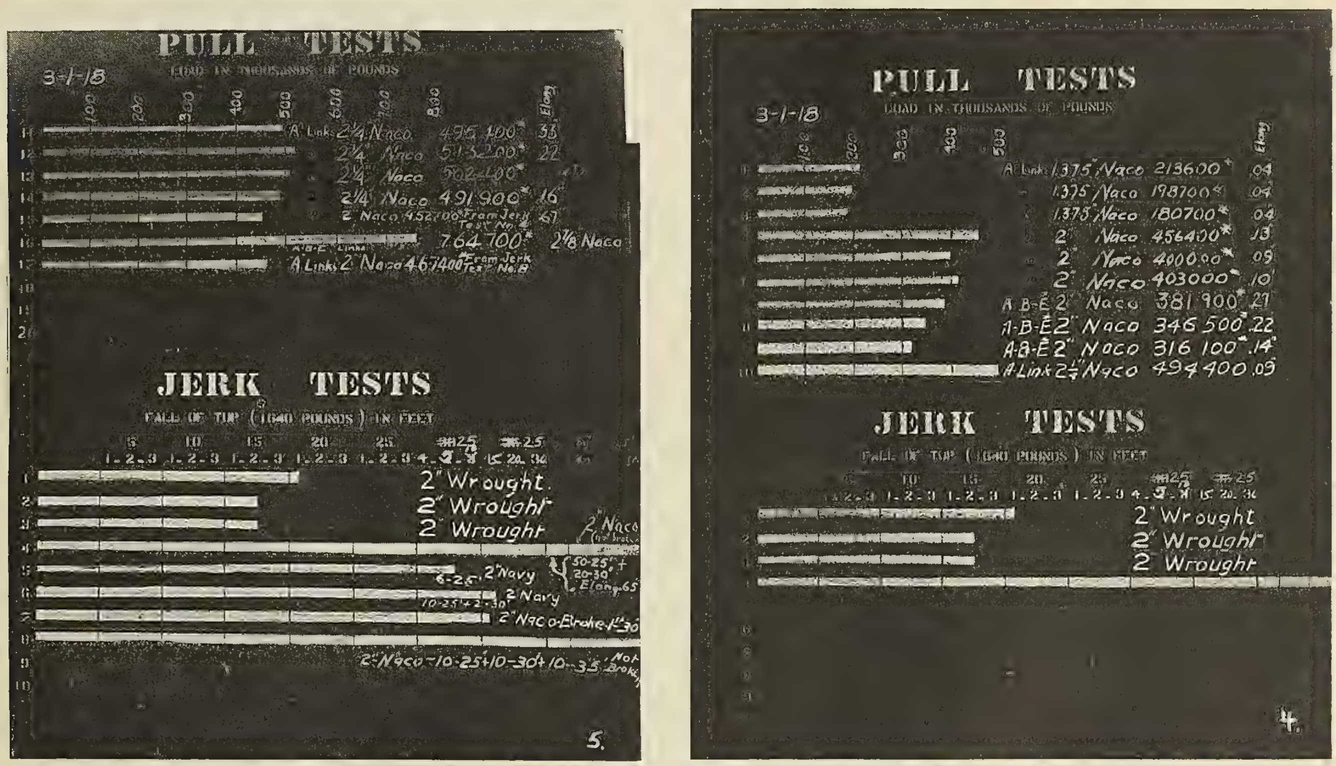

Fig. 8.—Results of Wrought and Cast Iron Tests in Both Pull and Jerk Machines

REPORT ON ANCHOR CHAIN TESTS

TEST GROUP No. 1.

Wrought iron link supported 8-inch centers.		"Naco" steel link supported 8-inch centers.	
Test No. 1.		*Test No. 2.*	
Load.	*Deflection.*	*Load.*	*Deflection.*
25,000 pounds	0.00 inch	145,000 pounds	0.00 inch
50,000 "	0.01 "	161,000 "	0.01 "
75,000 "	0.06 "	225,000 "	0.17 "
100,000 '	0.33		
125,000 '	0.83 "		
145,000 "	1.66 "		

Support pins slipped from under the link at 145,000 pounds load. Total number of degrees through which link bent 53.5.

Fractured one side of link close to stud at load of 237,300 pounds. Test continued and fractured remaining side at 145,000 pounds load. Section of metal through fracture shows solid.

TEST GROUP No. 2.

Wrought iron three-inch chain—static test.
Test No. 3: Center link fractured through end at 278,500 pounds load.
Test No. 4: Center link fractured through end at 237,500 pounds load.
Test No. 5: Center link fractured through end and side at 230,900 pounds load.
Naco steel—three-link chain—static test.
Test No. 6: Center link fractured through one side at 209,000 pounds load. Test continued and fractured remaining side at 93,800 pounds load.
Test No. 7: Center link fractured through one side at 231,400 pounds load.
Test No. 8: Center link fractured through one side at 210,000 pounds load.

TEST GROUP No. 3.

Separate link supported in M. C. B. pin test block. Weight of Tup 1,640 pounds.

Test No.	*Material.*	*Fall of Tup.*	*Deflection.*	*Remarks.*
9	Wrought	6 feet	21 degrees	No fractures
10	"	7 "	32 "	" "
11	"	8 "	.. "	Link broke
12	"	8 "	36 "	No fractures
13	Naco	8 "	11 "	" "
14	"	8 "	12 "	" "
15	"	10 "	Not measured	Link broke 2nd blow at 10 ft.
16	"	12 "	..	Link broke.

TEST GROUP No. 4.

Test No. 17: Wrought iron 5-link chain.
3 blows of 1640 pounds falling 5 feet........................chain O. K.
1 blow of 1640 pounds falling 10 feet........................chain broke.

Test No. 18: Wrought iron 5-link chain.
3 blows of 1,640 pounds falling 5 feet...........chain O. K.
3 " of 1,640 pounds " 10 feet........... " "
3 " of 1,640 pounds " 15 feet........... " "
2 " of 1,640 pounds " 20 feet........... " broke.

Test No. 19 Naco" steel 5-link chain.
3 blows of 1,640 pounds falling 5 feet...........chain O. K.
3 " of 1,640 pounds 10 feet........... "
3 " of 1,640 pounds " 15 feet........... " "
3 " of 1,640 pounds " 20 feet........... " "
3 " of 1,640 pounds ' 25 feet........... " "
3 " of 1,640 pounds " 30 feet........... " "
3 " of 1,640 pounds " 35 feet........... " "

Test discontinued after 3 blows at 35 feet with no apparent distortion or destruction of any one of the links.

Shipbuilding Costs and Estimates—I*

The Human Element a Large Factor—"News" and Not "History" Constitutes a Good Costing System

BY JAMES M. ROBERTSON

Costing is a system of recording results of work done so that a firm is able to tell: (1) The cost of producing any article made, and (2) the result of any operation.

Cost accounts deal entirely with the practical side of an industrial concern; any tendency towards their being mixed up with the general bookkeeping records of a company should at once be eliminated, as it only leads to delays and all sorts of complications. The figures in the two sets of accounts should agree, and the different books fit in sufficiently to permit of the totals being checked.

Briefly, the chief difference between cost and ledger accounts is that, while costing aims or endeavors to arrive at the net results of manufacturing by analysis—that is, to show what it costs to produce any specific item of work—the commercial accounts group together the results, not of each manufacturing process, but of each class of expenditures. The financial books will record the incomings and outgoings of cash and material over a given period, but the cost books, by analysis and grouping, will show the value of each important section of work done.

Generally, lines of organization rather than similarity of products, provide the best basis for a cost accounting system. Industries are, therefore, classified in this way and methods indicated which are applicable to particular businesses along these lines. Cost accounts are under two broad divisions—the *first* aims at ascertaining profit or loss on each particular contract; and the *second* ascertains how the cost of producing a commodity compares with its market price, both items being of a fluctuating character.

In operation, the above systems vary considerably. In small concerns, or where the detailed information required is of a limited character, the costing accounts are simple and the work demands little skill. In other undertakings, however, costing may be quite an elaborate business, requiring considerable skill and technical knowledge of the work if fallacious results are to be avoided.

A good cost system should be: (1) Simple in design and economical in its operation; (2) reliable in its methods and clear in its results, and (3) arranged so that records will be kept up to date.

What is wanted is to aim at a system which will secure, with the minimum of well-directed work, the most reliable results.

Cost accounts should be so arranged as to be easily followed by any man conversant with the business. Over-elaboration of detail must be guarded against and care taken that the value of the results obtained are in proportion to the labor spent in getting them. The system should not come under the reproach that more money is spent finding out what the article costs than in making it. On the other hand, it should be recognized that the less detail a firm keeps, the more dependent does it become in its search for new work upon a particular member of the staff.

As the human element is a very large factor in the success of any system, and the men working it may not be always so thoughtful and analytical as one might expect, it is very necessary that the methods adopted should be reliable and the results clear.

It has been said that a good costing system should supply "news" and not "history." Any system in which the records are not kept up to date with totals readily available loses quite half its usefulness. Comparisons with past results are continually required, and directors are often unsympathetic toward costing, largely because, as a rule, information is rarely available at the time it is wanted, and when produced later is of little use, since the occasion which called for it has passed. Again, if the accuracy of the final figures is to be assured, these should be compiled as quickly as possible after the contract is completed, so that any errors may be rectified while the work is fresh in the minds of all concerned.

* Abstract of a paper read before the Greenock Society of Shipbuilders and Engineers.

A good cost keeper should possess: (1) Speed and accuracy; (2) technical knowledge of the business, and (3) perspective.

As previously mentioned, since comparisons of present with past results are continually required, usually at very short notice, leaving little time available for checks, the need for speed and accuracy is obvious.

Possession of the second qualification is very desirable, otherwise stupid mistakes are likely to occur. A mere name knowledge of the articles produced is not sufficient to ensure correct records. This usually indicates that costing is being done in a routine fashion without thought or interest. When a man suggests a credit for waterways because he knows launchways have been credited, or extends two steel H.P. as two horsepower instead of two hawsepipes, or charges plates weighing 40 pounds per square foot against a destroyer's cost, and sees nothing wrong, then the need of technical knowledge is evident.

The possession, or the cultivation, of the faculty of perspective by men engaged in costing will go a long way toward ensuring the efficiency of any system. The ability to know how much time and labor may reasonably be spent in compiling records in relation to their ultimate value cannot be overestimated. A system may owe its success or failure to the presence or absence of this qualification in its working. The chances are that where the money spent on costing is out of proportion to the value of the records obtained, it is not so much a defect in the system as lack of perspective on the part of those responsible for carrying out the work.

Advantages of a Good Costing System

A good costing system enables detailed comparisons to be made between the estimated and the actual cost of contracts, as well as between past and present results and output of work in each trade; it encourages greater all-round efficiency in working by showing where output may be increased and production cheapened; it forms a basis for estimating.

How to Get the Best Results From a Costing System

As far as possible costing work should be made self-contained and independent of any outside department for its data.

The work should be arranged to be as interesting as possible.

In many firms costing is in the hands of one man, with possibly an assistant to help him. The duties are practically limited to the collection of figures from other departments and their allocation against the respective cost divisions.

While it is recognized that in small concerns it may not be possible to depart to any great extent from the above method, still such a system rarely gives the best results. Such an arrangement makes the costing department too dependent on other departments, which are often unsympathetic with the aims and objects of costing, for figures. Much of the cost-keeper's work accordingly becomes uninteresting and mechanical.

Where possible it is advisable to make all clerks handling material for vessels cost clerks. A man should have a section of the work, one, two or more trades to look after, according to the size of the concern and the extent of its output. He should carry through practically all the work—pricing, abstracting and unimportant correspondence regarding tenders and delivery, as well as be responsible for the stock. Under the supervision of a responsible head cost clerk the work of subordinates is thus made more complete, variable and interesting, and better final results are likely to be obtained.

In the past there has been too much secrecy about methods of cost keeping in shipbuilding. While it is in order to keep the result of the actual workings of a firm secret, yet it would be to the advantage of the industry if all shipyards had a fairly detailed costing system in operation. If some standard system could be adopted whereby all came into line in their methods of charging material and labor, and dealing with establishment charges, shipbuilding would benefit. Much undue competition for new work would thereby be eliminated, as the firm that contracts for new work at a ridiculously low figure to its later regret is not as a rule the one in possession of the best costing system.

Shipbuilding Cost Accounts

A separate account for each contract is kept so that the profit or loss can be readily ascertained, while over and above this a detailed analysis of all work done and material supplied is kept in a suitably arranged form. Shipbuilding is too extensive in its operations to lend itself to the same accuracy of costs as are associated with certain other manufacturing concerns. This fact should be recognized and efforts made to strictly limit probable errors without an undue expenditure of time and labor. As values and quantities are usually large, a small percentage of error in no way detracts from the value of the costs.

Material

The first subdivision of the material naturally falls under that of trades, and lump-sum figures are available at the completion of a contract showing the respective trade costs. These broad divisions are further subdivided usually on a job basis according to plan, and lists are issued to the drawing office and all other departments concerned. Costs of every important section of work done by each trade are thus arrived at.

The proportion of material purchased for purely stock purposes is generally very small. As far as possible all material is specified against particular work in hand, and debited direct to the ship when invoiced. However, certain materials, such as rivets, hardware, electrical fittings, paints, timber, etc., do not readily lend themselves to direct charging, as they can only be ordered in approximate quantities for each ship.

To ensure greater accuracy and avoid possible credits or debits at the completion of the vessel it is better to debit this material to a stock or store account, and have it charged against the ship when requisitioned for her by an order from the foremen, the store account being then credited with the amount. All material ordered is usually according to specification received from the drawing office, which should mark thereon the job and cost division number it is to be charged against.

The figures for the issues from stores should be posted fortnightly or monthly from separate books and should be checked with ledger figures. These separate books should contain suitable summaries of value of material charged through store sheets.

Detailed particulars of the material charged direct should be available in suitable form. Hull castings (or forgings) include: Stem, stern-post, propeller brackets, rudder frame, etc. Deck machinery includes: Winches, cranes, windlass, capstan, steering gear, refrigerating and electric plants, disinfector, etc. Outfit, etc., includes: Anchors and cables, upholstery, boats, cooking gear, lamps, chandlery, nautical instruments, canvas gear, hawsers and reels, etc. Sundry cash items include: Classification fees, passenger certificate, hull insurance, towage, cranage, dock dues, purveying at trial, freight, etc.

Work is usually done under one of two wage-payment systems—time rate or piecework. While it is not so difficult to get a record of jobs done on piece as on time, yet the importance of accuracy in allocating jobs against their respective classification number is not generally and fully recognized. When one considers the time and labor spent in compiling data it is surely false economy to adopt any other than the best possible measures to ensure that work be correctly charged.

The best results are usually obtained by a timekeeper going among the men at least once a day and taking a record of their work. If possible a tradesman thoroughly conversant with the work should be employed. If the interest and sympathy of the foreman can be enlisted to roughly scrutinize the allocation of work done, then greater accuracy will be ensured. As far as possible job classification numbers should be standardized so as to repeat themselves and stand for the same section of work in successive vessels.

The extra hours paid to men when employed after hours over and above those actually worked should be kept under a separate acceleration number and charged as a "breakage" to cost of vessel.

Establishment Charges

Establishment charges embrace expenditures incurred in: (a) The necessary carrying on of a business; (b) increasing the production power of labor; and the particular items of outlay, which in each case cannot be readily allocated directly against work in progress. Among other things this "oncost," as it is sometimes called, should cover depreciation, obsolescence and certain capital risks, but not remuneration on capital invested in the business.

So far as shipyards are concerned, the labor basis commonly in use, though not by any means accurate, may be taken on the whole as the best. It has the merit of simplicity in its favor, and it certainly enables the estimator to deal with this part of his work readily. In allocating charges over actual costs, however, some discrimination might be made between the wages paid to purely hand workers on board a vessel at a fitting out basin and men employed in the works using space, plant and power.

While the allocation of charges on a labor basis appears on the whole satisfactory, some further division of charges would seem necessary. A firm should know what proportion the irreducible part of its cost bears to the total.

Fixed and Fluctuating Charges

The practically fixed portion of the costs would include such items as rent, rates and taxes, general management expenses, office salaries, building repairs, depreciation and sundry expenses.

The fluctuating portion moves broadly in harmony with output and would include plant repairs and renewals; electric current and power, coal, coke and gas, fuel oils, naphtha, gasoline (petrol), oxygen, drillers' grease, wages of storemen, winchmen, cranemen and stationery.

The benefit of this division between fixed and fluctuating charges becomes apparent if a firm has to cut in very keenly for work. Assuming the net cost without profit of a ship at $475,000 (£100,000), of which $95,000 (£20,000) is charges—$33,250 (£7,000) of this $95,000 (£20,000) is fluctuating, and the balance $61,750 (£13,000) is fixed, charges. At a push it may pay a firm to accept, rather than decline, this order at, say, $441,750 (£93,000), as by so doing they receive the direct cost of material and labor, viz., $380,000 (£80,000), plus the $33,250 (£7,000) fluctuating on cost, plus $28,500 (£6,000) towards the reduction of their fixed charges, which are running on whether they get work or not.

The question of charges does not as a rule come under the review of the average shipbuilding costing department. Their work is usually limited to prime cost, i. e., dealing with material and labor only. It is suggested that a firm might with advantage consider the advisability of bringing this work more within the scope of costing, with a view to keeping a better record of its incidence and securing a more equitable distribution of its totals over the work done. The following summary of items which it is considered are best dealt with in charges may be useful:

Items Suggested To Be Included in Establishment Charges

The Use of: Buildings, berths, machinery, yard, cranes, derricks and gear, uprights, shores, stage planks, keel blocks, launching gear, small tools, bolts and wedges.

Power for and Use of: Acetylene, hydraulic, electric and pneumatic plants.

Salaries and Wages: Officials, clerks, typists, yard engineers, machinemen, electricians, laborers, watchmen, furnacemen, gatemen, storekeepers, timekeepers, messengers and attendants.

Cost of: Rent, feu duties, rates, taxes, gas, electric light and power, naphtha, lubricating and fuel oils, drillers' grease, gasoline (petrol) for blow-lamps, yard insurance, office cleaning and purveying, D. O. material, data and records, coal and coke, waste, stationery, packing materials, telephones, telegrams, postages, advertising and charities.

Suggested that: Employers' liability and national insurances be debited either monthly or quarterly direct to the vessel, under material, as a percentage on wages spent.

To sum up, it is held that a cost system should be considered an investment and not an expense. No claim is made that cost accounts will in themselves cure inefficiency in management or permit a concern being run without a manager, or save a business from failure. It is contended, however, that the system will supply real live information which, if properly used, will do much to promote and aid efficiency; while a firm which knows actually where it stands from week to week is much less likely to become bankrupt than one which is directed during the year by guesswork.

(To be concluded.)

Lengthening Ships to Increase Their Capacity

"It occurs to me that there must be a good many steamships whose speed would be improved by lengthening them besides increasing their carrying capacity at the same time," writes a foreign contributor in a recent issue of the *Scientific American.* "The cutting of the hull and the rejoining of it to the additional length would be a job for a dry dock and a shipbuilder. But the lengthening section could be fabricated in any bridge builder's or boiler maker's yard. If a knot an hour and a five percent or ten percent increase of carrying capacity could be got at one and the same time it would seem that in this way (applied to ships whose lines show that lengthening would increase their speed) the greatest advantage would be taken of existing vessels, expert builders and 'fabricators.' Cutting a hull is a matter of hours. The 'fabricators' would 'get their hands in' on that part of a ship, which might be turned out by a rolling mill and sold by the yard, for all the change in cross section that occurs is in 50 feet of it. Given suitable existing ships, I do not think any quicker way of effecting an increase in tonnage exists, with the means at your disposal."

Investigation of Shearing Force and Bending Moment on Ship Structures*—II

Moderate Amplitudes of Heave—The Sagging Bending Moment—Pitching Treated Graphically—Effect of Rotational Acceleration

BY A. M. ROBB, B. SC.

SHEARING force and bending moment curves, *including* the effect of heaving, obtained in the manner previously outlined, are shown in Figs. 4 and 5. Fig. 4 is for the vessel in the "standard hogging" condition of loading heaved 4.95 feet out of the wave crest, the reduction in buoyancy being about 32 percent. Fig. 5 is for the vessel in the "standard sagging" condition of loading heaved 5.11 feet into the wave trough, the increase of buoyancy being about 32 percent. For comparative purposes, the corresponding statical curves are shown on the same base lines as the "heaved" curves.

The reasons underlying the choice of amplitudes of heave are outlined in an appendix. It is not suggested that such values are ever realized in practice; but data on the subject are very scant; the only information of value that has been traced is contained in Mr. Stromeyer's contribution to the discussion on Professor Jenkins' 1890 paper where he refers to a weight suspended from a spring balance in a heaving ship showing readings 10 percent above and below the normal.

Alteration of Weight and Bending Moment

In Professor Jenkins' words: "The consideration which governs this question of increase or decrease of the bending moment is one entirely of the relative longitudinal positions of the center of gravity of the fore or after body of the vessel, and of the layer of water which is additionally immersed or emerged." Considering the portion of the ship aft of the position of maximum bending moment, it is seen that the "virtual" alteration of weight acts in the same lines as the normal weight; for moderate amplitudes of heave the alteration in buoyancy must act in a vertical line very near to the line of action of the normal buoyancy. Thus it naturally follows that the percentage alteration of bending moment due to heaving cannot be widely different from the percentage alteration of displacement. This is not actually borne out by the results given in Figs. 4 and 5. For the "standard hogging" condition the percentage reduction of bending moment is about 20, corresponding to a percentage reduction of displacement of 32; for the "standard sagging" condition the percentage increase of bending moment is about 13, corresponding to a percentage increase of displacement of 32. But it should be borne in mind that the amounts of heave adopted in the determination of Figs. 4 and 5 are probably excessive. It is reasonable to infer that for moderate amounts of heave the center of buoyancy of the layer is farther from amidships than the center of buoyancy of the fore or after bodies in the hogging condition, and nearer amidships than the center of buoyancy of the fore or after bodies in the sagging condition; so it is a further inference that the percentage variation in bending moment due to heaving is slightly less than the percentage variation in displacement.

A noteworthy point which emerges from this consideration of heaving effects is that the sagging bending moment *including* heaving is not nearly so large as the statical hogging moment, the respective values being 74,000 foot-tons and 27,000 foot-tons. Such a result is quite to be expected in the case of an ordinary merchant steamer. In four cases of intermediate type vessels examined, the ratios of maximum sagging moment to maximum hogging moment, statical, ranged from 1 : 1.4 to 1 : 2.1. Obviously,

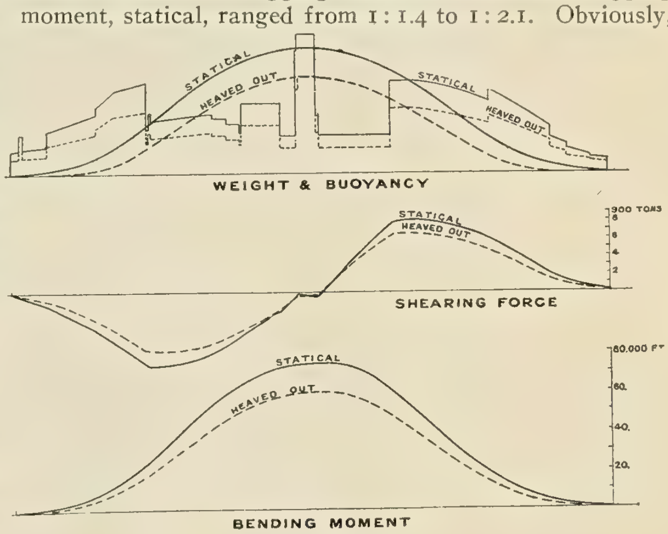

Fig. 4

no reasonable amount of heave would in any of these cases bring the sagging moment up to equality with the hogging moment. On the other hand, in the cases of a Channel steamer and a fast liner, the maximum statical hogging and sagging moments were found to be approximately equal. In such cases, the effect of heaving would be to make the sagging moments quite considerably larger

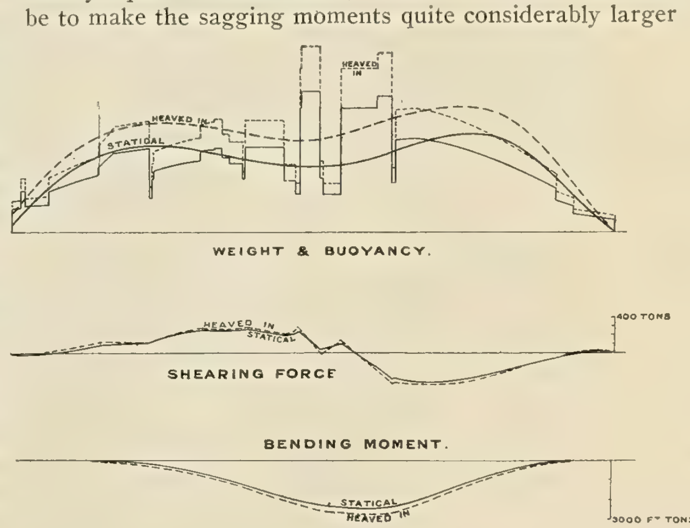

Fig. 5

than the hogging moments. But in vessels which have not large machinery weights concentrated amidships, it would seem safe to leave the effect of heaving entirely

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* From a paper read at the spring meetings of the fifty-ninth session of the Institution of Naval Architects, London, March 22, 1918.

out of account, and, in fact, to make the statical hogging calculation basis of longitudinal strength considerations.

The case of pitching can be treated graphically similarly to that of heaving.

In this case it is assumed that pitching motion can exist independently of heaving motion; in other words, it is assumed that a vessel can traverse a series of waves in such a manner that, while the displacement remains the same, the position of the center of buoyancy is continually varying.

The consideration of the effect of pitching motion is very similar to the consideration of the effect of heaving motion, the rotational acceleration, alternately clockwise and anti-clockwise, of the pitching motion corresponding to the vertical acceleration, alternately upwards and downwards, of the heaving motion. A very close analogy between the two motions is obtained if, for each short length of the ship, the rotational acceleration be converted into a linear acceleration; for example, if the rotational acceleration is

$$\frac{d^2\,\theta}{d\,t^2},$$

the linear acceleration at a distance $\pm\, r$ from the axis of rotation, assumed to be at the center of gravity, is

$$\pm\, r\,.\,\frac{d^2\,\theta}{d\,t^2}.$$

Thus in the case of pitching there is also, in effect, vertical acceleration, but in one end of the ship it is upwards when in the other it is downwards, and vice versa. As in the case of heaving, a downward acceleration is accompanied by a "virtual" decrease in weight, an upward acceleration by a "virtual" increase of weight. For example, when the bow is "pitched" out of the water the acceleration acts downwards over the forward portion of the ship, and the weight of that portion is "virtually" decreased; at the same time the acceleration is upwards over the after portion of the ship, so that its weight is "virtually" increased. The "virtual" alteration in weight at any point is expressed by

$$\pm\,\frac{w}{g}\,.\,r\,.\,\frac{d^2\,\theta}{d\,t^2},$$

w being the normal weight at that point, and r its distance from the center of gravity; the plus sign is used if the part considered is "pitched" into the water, the minus sign if "pitched" out of the water. The acceleration

$$\frac{d^2\,\theta}{d\,t^2}$$

is the same along the length of the ship, and g is a constant; therefore, the "virtual" alteration in weight is proportional simply to $w\,.\,r$, and so is proportional to the moment of weight about the center of gravity.

The effect of the rotational acceleration is that the distribution of the "virtual" weight varies, and so the center of gravity "virtually" oscillates about its statical position, being aft of that position when the stern is "pitched" into the water, and forward of it when the bow is "pitched" into the water. Since by assumption the displacement remains constant, the weight also remains constant. Con-

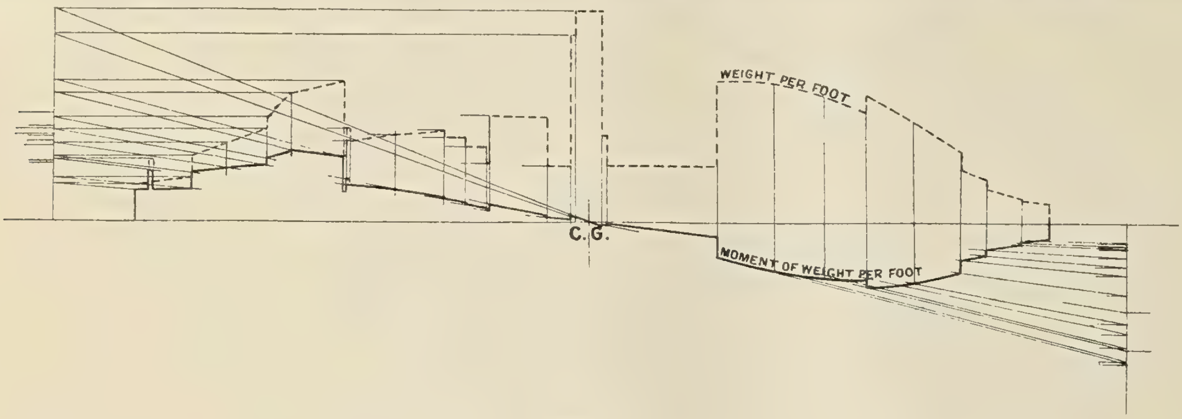


Fig. 6

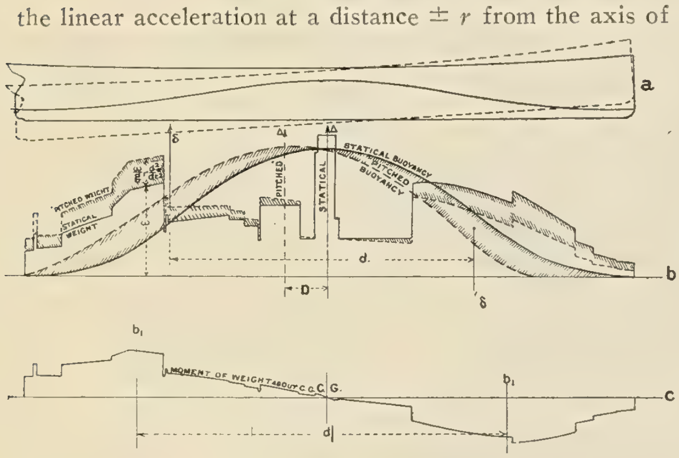


Fig. 7

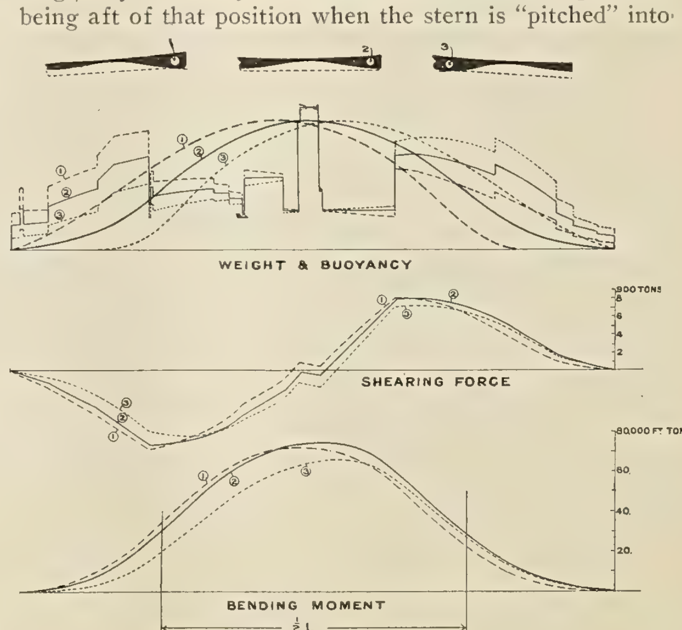


Fig. 8

trasting the cases of heaving and pitching, it is seen that in the first case there is a variation in weight and buoyancy, the fore-and-aft position of the center of gravity being unchanged; in the second case there is a variation in the fore-and-aft positions of the centers of gravity and buoyancy, the weight and buoyancy being unchanged.

The investigation of the effect of pitching upon shearing force and bending moment involves the use of a curve of moment of weight per foot of length about center of gravity. A very neat method of obtaining this curve has been outlined by F. H. Alexander in the appendix to his paper on "The Influence of Longitudinal Distribution of Weight Upon the Bending Moments of Ships Among Waves," read before the Institution in 1911. An example of the method is given in Fig. 6.

To obtain the curves of shearing force and bending moments it is necessary to obtain a curve of virtual weight.

Referring to Fig. 7, diagram (a), the solid lines show a vessel in statical equilibrium on the crest of a wave; the dotted lines represent the vessel "pitched" through an angle of four degrees, the displacement remaining constant. As a result of the "pitch," a wedge of buoyancy is transferred from the fore body to the after body. Let the moment of transference of buoyancy equal m. This is determined by taking the product of the displacement into the shift of the center of buoyancy; for example, referring to diagram (b), $m = \Delta \times D$; alternately, $m = \delta \times d$, δ being the displacement of either wedge, and d the distance apart of the centers of buoyancy of the immersed and emerged wedges. The acceleration, clockwise in this case, is given by

$$\frac{W}{g} \cdot k^2 \cdot \frac{d^2\theta}{dt^2} = m,$$

and

$$\frac{d^2\theta}{dt^2} = \frac{m \cdot g}{W \cdot k^2},$$

where k is the radius of gyration of the mass of the ship about the center of gravity.

The moment of inertia of the mass of the ship, and so the radius of gyration, can be determined from the second integral of the moment of weight curve. From this it is possible to evaluate

$$\frac{d^2\theta}{dt^2}.$$

Actually, however, it is not necessary to evaluate

$$\frac{d^2\theta}{dt^2}.$$

It has been seen that, on account of the rotational acceleration, any element of weight w is subject to an addition

$$\pm \frac{w}{g} \cdot r \cdot \frac{d^2\theta}{dt^2}.$$

The moment of the addition about the center of gravity is

$$\left(\pm \frac{w}{g} \cdot r \cdot \frac{d^2\theta}{dt^2}\right) \times (\pm r), \text{ or } \frac{w}{g} \cdot r^2 \cdot \frac{d^2\theta}{dt^2}.$$

Hence the total moment causing the "virtual" shift of the center of gravity is

$$\Sigma \left[\frac{w}{g} \cdot r^2 \cdot \frac{d^2\theta}{dt^2}, \text{ or } \frac{W}{g} \cdot k^2 \cdot \frac{d^2\theta}{dt^2} \right]$$

This quantity is equal to the moment of transference of buoyancy. Thus it is seen that during the pitching motion the "virtual" center of gravity is always in the same vertical line as the "pitched" center of buoyancy. Accordingly, it is necessary to alter each ordinate of the weight curve by an amount representing

$$\frac{w}{g} \cdot r \cdot \frac{d^2\theta}{dt^2},$$

under the condition that the effect of the alteration is to bring the "virtual" center of gravity into the same vertical lines as the "pitched" center of buoyancy.

Referring again to Fig. 7, diagram (c) represents the moment of weight curve corresponding to the statical weight curve in diagram (b). Since

$$\frac{d^2\theta}{dt^2}$$

is the same along the length of the ship, and g is a constant, any ordinate of diagram (c) represents

$$\frac{w}{g} \cdot r \cdot \frac{d^2\theta}{dt^2},$$

and so diagram (c) may be taken to represent the "virtual" alteration in weight due to the rotational acceleration. It is necessary, accordingly, to adjust the vertical scale of diagram (c) so that the moment of transference given by it shall equal the moment of transference of buoyancy

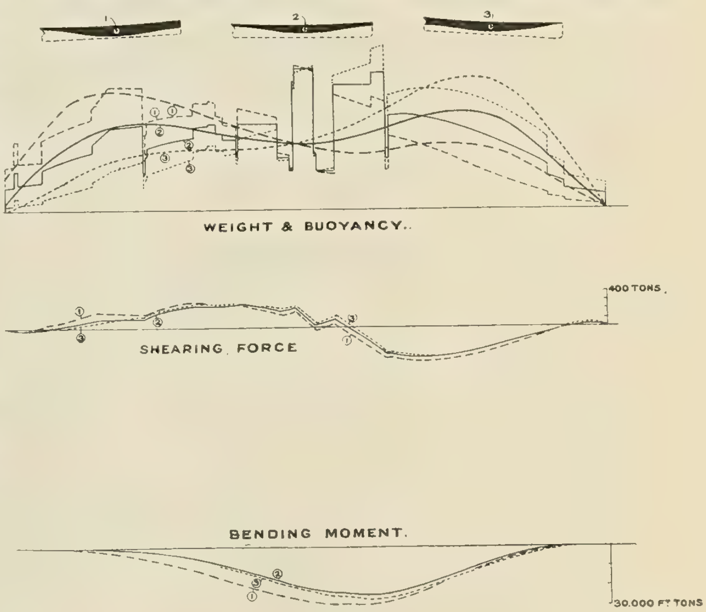


Fig. 9

found from diagrams (a) and (b). By means of an integrator set with the axis perpendicular to the base line, the areas and centers of areas of the positive and negative portions of the diagram are determined. Since the total moment of weight about center of gravity is zero, the areas of the two portions are equal and are represented by b_1, say. Let the distance apart of the centers of area be d_1. Then, "virtual" moment of transference of weight $= b_1 \times d_1$, and this must be equal to the moment of transference of buoyancy ($\delta \times d$), or m. So long as the length of base of the moment of weight diagram is unchanged, the centers of area are in the same longitudinal position, and are not affected by any change in vertical scale. Accordingly, any desired moment of transference can be obtained by altering the vertical scale of the moment of weight curve. For example, let the area representing b_1 in diagram (c) be A_1; and suppose it is found that ($A \times d_1$) represents ($\delta \times d$). Evidently it is necessary to alter the area of diagram (c) until it is the desired quantity A; this is done by altering every ordinate in the proportion

$$\frac{A}{A_1}.$$

Instead of plotting a new moment of weight curve whose area will be the desired amount, the amended ordinates are used for the correction of the statical weight curve. In this way the "pitched" weight curve in diagram (*b*) of Fig. 7 was obtained. This "pitched" weight curve has each ordinate amended by a quantity representing

$$\frac{w}{g} \cdot r \cdot \frac{d^2\theta}{dt^2}.$$

moment curves can be obtained by integration in the ordinary manner. Such curves are curves *including* the effect of pitching. Examples are given in Figs. 8 and 9, the amount in each case being 4 degrees. The corresponding statical curves are also given, marked "2" in each case.

The investigation of the effect of pitching was carried a stage farther by varying the distribution of the cargo carried in the two "standard" conditions. The total amount of cargo carried was kept constant, as was the position of the center of gravity; but the cargo was concentrated in Nos. 1 and 4 holds, and in Nos. 2 and 3

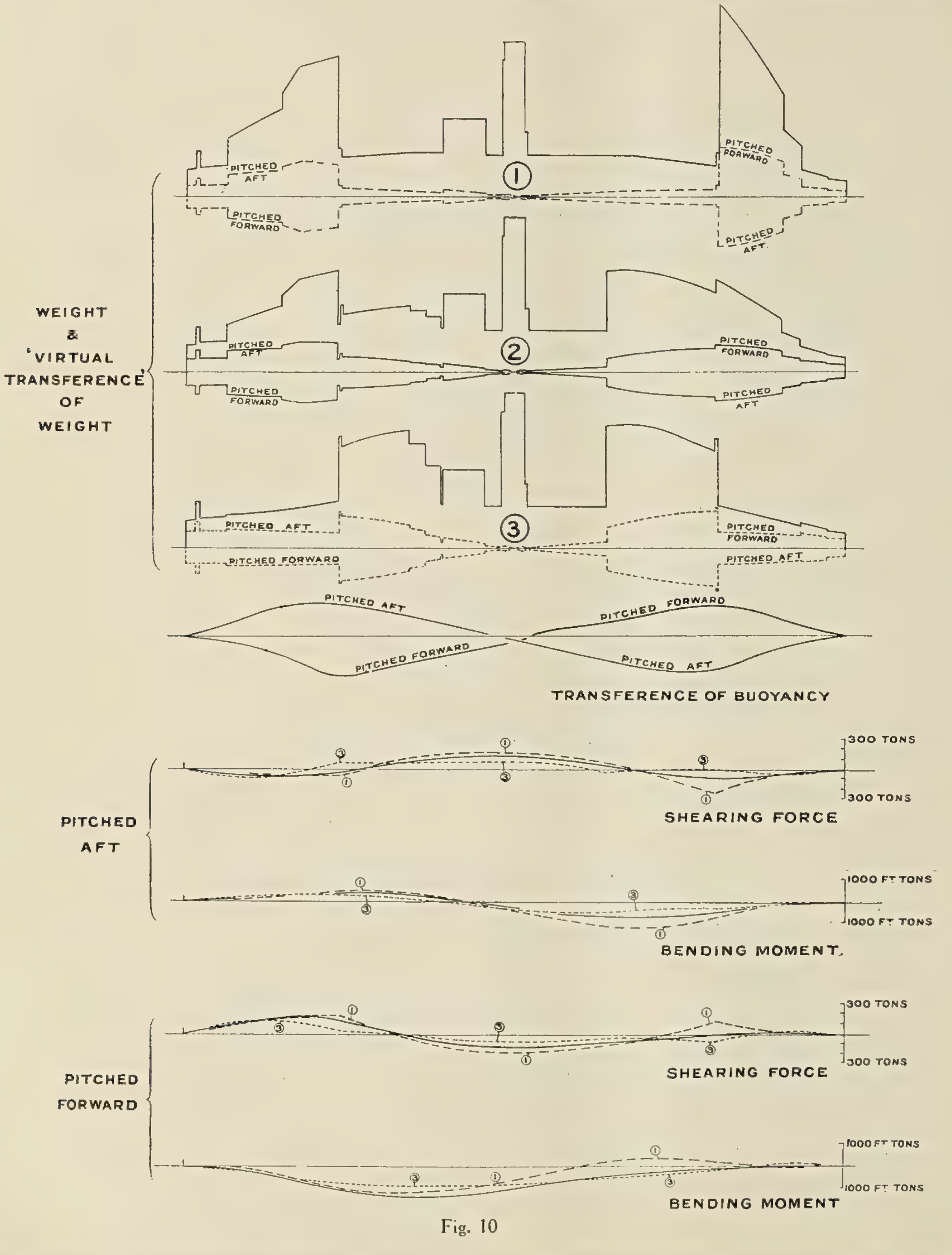


Fig. 10

the extent of the amendment being such that the "virtual" center of gravity is in the same vertical line as the "pitched" center of buoyancy.

From "pitched" weight and buoyancy curves obtained in the manner outlined above, shearing force and bending

holds. Thus the weight curves shown in Figs. 10 and 11 were obtained. In each case the weight curve marked "1" is that which will produce the maximum statical bending moment; the curve marked "2" is the "standard" loading.

Corresponding to these distributions of weight, curves

of "virtual transference" of weight were obtained in the manner outlined above; these are shown in conjunction with the weight curves. From these "virtual transference" curves in association with the curve of transference of buoyancy shearing force and bending moment curves *due* to pitching were obtained by integration in the usual manner; these curves are shown in Figs. 10 and 11. The "solid" curves correspond to the "standard" conditions able, though not sufficient to bring the sagging moment to equality with the hogging moment (see Figs. 9 and 11).

Considering now the effect of distribution of cargo, Figs. 10 and 11 indicate that this has a considerable effect on the shearing force and bending moment *due* to pitching. But it must be borne in mind that the statical curves corresponding to the weight curves in Figs. 10 and 11 will be widely different, and it seems a reasonable inference that,

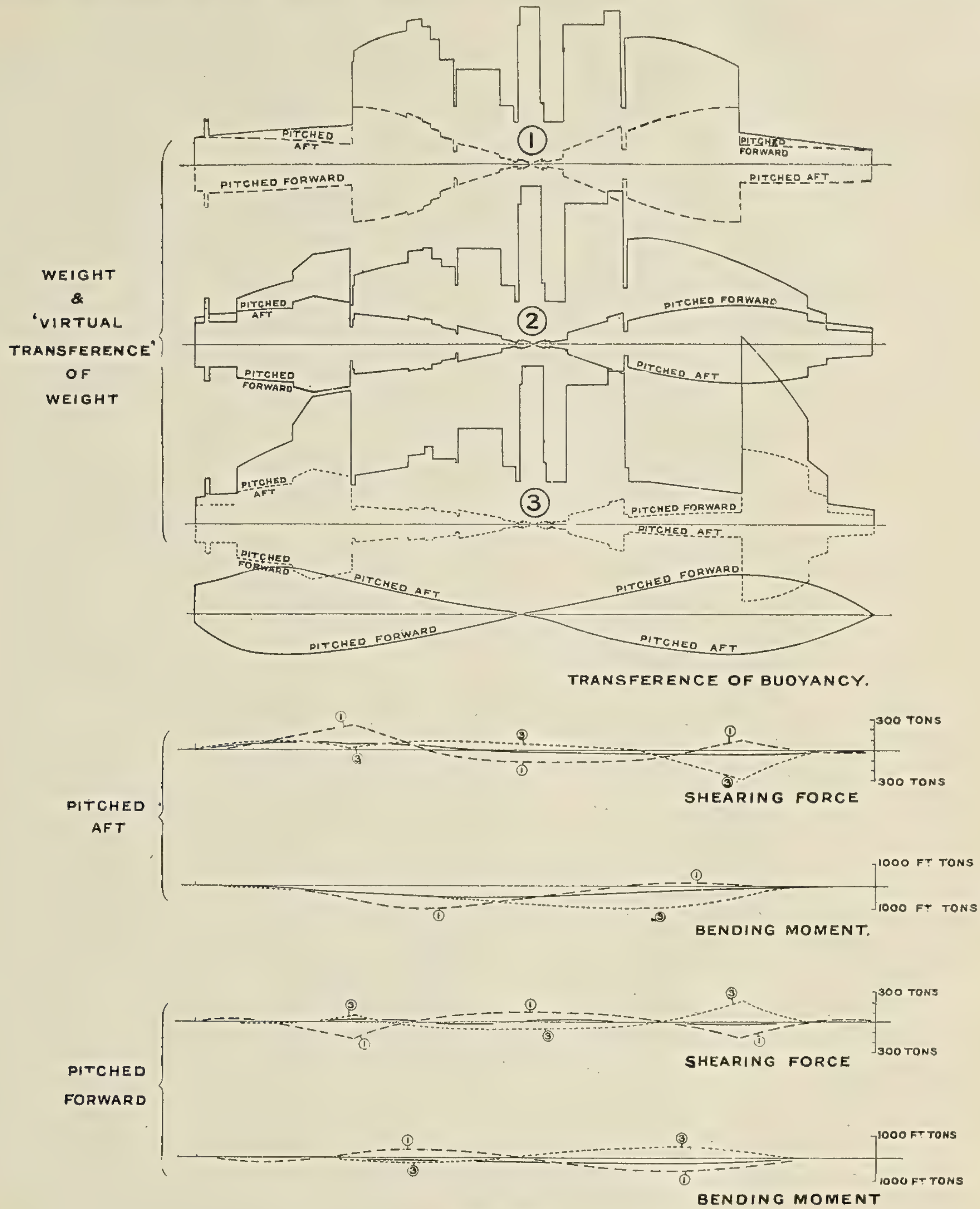


Fig. 11

of loading, and so are the intercepts between the "pitched" and statical curves of Figs. 8 and 9.

From Figs. 8 and 10 it is evident that, for the particular ship considered, the effect of pitching when in the hogging condition is not of great importance, causing, as it does in the worst cases, only a relatively small increase of bending moment over the ends of the vessel. On the other hand, for the same amount of pitch, when in the sagging condition the effect of pitching is quite consider- relatively to the corresponding statical curves, the curves marked "1" do not represent so great an effect as the curves marked "3." From this a possible inference is that the better the condition of loading as regards statical conditions the worse the condition as regards dynamic effects, and vice versa.

One object of the investigation outlined above was to obtain, if possible, a bending moment curve, or the "envelop" of a series of bending moment curves, which

would be almost flat in the region of the maximum value. This object has not been realized; even if the effect of pitching be included, the bending moment curve maintains approximately its maximum value over a very short range. Accordingly, the bending moments at the half lengths are always considerably less than the maximum values (see Figs. 1, 2, 8 and 9). The question then arises: Is it not possible, in many cases, to obtain sufficient longitudinal strength without maintaining the full midship scantlings over half the length?

A point of interest which arises from the pitching calculations is the effect of the pitching on local loads. For example, referring to the weight curve marked "1" in Fig. 11, it is seen that, due to pitching, the "virtual addition" to an element of weight in either end is practically equal to the normal weight; thus the weight of a windlass, say, may "virtually" be doubled as the result of pitching acceleration. Obviously the strength of the pillaring under the windless is not affected by the acceleration, and so in any case of stiffening under a local load the effect of pitching acceleration demands some attention, bearing in mind always that the effect is maximum at the ends, and minimum amidships. This consideration naturally leads up to the determination of the amplitude of pitching; it may be, for instance, that the combinations of pitching amplitudes and wave positions adopted above are highly improbable in practice. It is suggested that this matter can be investigated in an experimental tank. Waves of a desired period can be created; the ship model can be made dynamically accurate.

Taking Records of the Motion

From this point there remains only the observation of the motion. This might be carried out by means of the vertical cylinders used for measuring change of trim, an observer noting times at which wave crests passed the stern. Alternatively, a cinematographic record might be made, the positions of the ship on the wave being given by a series of draft marks along the side. In this way maximum amounts of "heave" and of "pitch," separately and in combination, might be determined. Then, for example, it might be found that a particular combination of heaving and pitching would possibly produce an excessive bending moment. The corresponding buoyancy curve would be drawn and its area determined. The weight curve would be proportioned up to the area so found; this would take account of heaving. By means of the moment of weight curve the "virtual center of gravity" would be placed in the correct position. Then from the amended weight curve and the buoyancy curve the shearing force and bending moment curves, including *both* heaving and pitching, would be obtained.

It might even be possible to carry the investigation of the motion of the model a stage farther and measure by means of special spring balances the variations of "virtual" weight along the length and so obtain curves of "virtual" weight for the model. These curves of "virtual" weight might be checked with the corresponding buoyancy curves, and so the application of the "Smith" correction tested.

In conclusion, I desire to acknowledge the great benefit derived from T. C. Read's paper, "On the Variation of the Stresses on Vessels at Sea Due to Wave Motion," Transactions Institution of Naval Architects, 1890, and from F. H. Alexander's paper, "The Influence of Longitudinal Distribution of Weight Upon the Bending Moments of Ships Among Waves," Transactions Institution of Naval Architects, 1911.

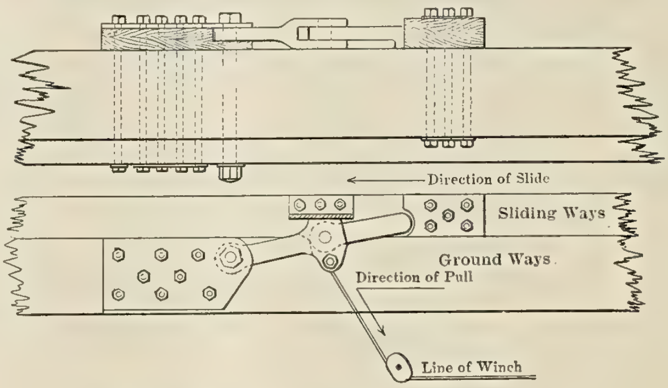
It is hoped that this treatise will prove of use to all naval architects who are interested in carrying forward these investigations.

Trigger Apparatus as Safety Factor at Launchings

The means and methods of launching or starting a vessel down the ways at the exact time and entirely at the will of the sponsor may be a puzzle even to men who have spent months around a shipyard. It is doubtful if one man in ten has a correct idea of just how to start a launching.

The release of the cradle or sliding ways so that they can start and slide freely down the greased ground or standing ways, carrying the enormous weight of the ship's hull safely into the water, has been accomplished by using several devices, one or two of them very old. One of the latest devices is described by Frank Gollan, superintendent of the G. M. Standifer Construction Corporation's wooden yards, Vancouver, Wash., as follows:

Under the bottom of the hull to be launched are placed two parallel fore and aft timbers, called the cradle, sliding or traveling ways. These timbers are carefully shaped and fitted to the outside contour of the ship's bottom at the location where the cradle carries the weight of the ship. The under side of these cradle timbers rests on the greased



Trigger Apparatus as Safety Factor at Launchings

surface of corresponding fore and aft timbers blocked up from the permanent timber structure of the shipbuilding ways, which are called standing, inboard, or ground ways. These timbers are laid straight with the outboard or stern ends which are nearest the water and lower than the ends at the bow, thus giving a slight inclination of the top surface towards the water, just enough to start the ship without force when it is released from its permanent attachment to the shore. One of the latest devices, illustrated herewith, is called a "trigger." This device is the last link between the ship's stay on land and her start towards the water. It is by this device that she is cut loose and the first step in launching is accomplished.

The ship is first wedged up. Then the big bilge shores are knocked out from under the vessel. Men then go under the ship between the ways and, starting aft, work forward toward the bow, splitting out the keel blocks. After this has been completed the great weight of the ship rests on the cradle and launching ways.

The trigger keeps the sliding ways or cradle from sliding down the ground ways into the water. This is a knuckle device, so designed that the greater the strain on the trigger, the more securely will it hold the ship in position. Since there are two tracks to the ground ways, it is necessary to have two triggers, one on each side of the keel, attached to the cradle and the ground ways. In order that they shall operate together, a cable is attached to each trigger. These two cables are brought together into a "bridle," to which a cable is attached leading directly to the drum of a winch, which, at a signal, the operator starts.

Control of Hull Construction of a 5,000-Ton Deadweight Fabricated Steel Vessel

Adopting a Drawing Room Policy—Development of Schedule to Control Production—Classification of Work and Relative Values

BY FABRICATOR

To secure satisfactory results from the drawing room, a policy must be followed which will not tie up the shop, will give constant employment to the regular drawing room staff and will eliminate, in so far as is possible, overtime and "extra men." This can best be accomplished by a careful analysis and classification of the work to be done and by working to a predetermined schedule based on an estimate of the work and using such standards as are available. The time is nearly always definitely known.

As the preliminary plans, diagrams and various calculations cannot be arbitrarily controlled with satisfaction, the naval architect should be instructed to prepare immediately all of the necessary erection diagrams covering the shell, vertical and side keelson, floors, tank top, bulkheads and decks, together with the preliminary framing, pillar and girder plan. The production of the mold loft offsets, launching diagrams and various ship calculations was left to the judgment of the naval architect and was held for the attention of his regular staff of ship's draftsmen.

Plans to cover the work to be done at the yard were prepared by the regular staff according to shipyard practice, but in conjunction with the fabricating plans. Most of the detailing was left for the mold loftsman to develop. This scheme enabled us to build up an organization of structural steel draftsmen to turn out the plans required for the work to be done by the fabricating shops. A schedule was developed to control the production of these plans.

The contract classification of the work and the price paid the fabricator for the different classes of work were used as a basis for assigning relative values to the classes which were to be covered by the drawings or plans to be made. These plans were classified in accordance with the fabricator's schedule. In the case under consideration, the classification of work and relative values assigned were as follows:

Class	Description	Relative Value	Weight
A	Punching flat rectangular plates...	.279	520
B	Punching flat sketch plates.......	.126	203
C	Punching straight shapes.........	.003	20
D	Complete open and solid midship floor—includes intercostals......	.110	85
E	Complete open and solid forward and aft floors—includes intercostals	.132	90
F	Complete center vertical keelson..	.023	22
G	Complete pillars.................	.006	10
H	Hatch coamings, complete........	.016	20
I	Frames, complete.................	.061	95
J	Deck beams, girders, bulkhead stiffeners, angle columns and struts, complete................	.100	155
K	Panting stringers, brackets and gusset plates, all foundations, breast hook and stays—fore and aft web frames................	.069	50
L	Complete watertight and oiltight floors	.062	40
M	Shear strake doubling plates......	.013	20

It was necessary to complete all drawings at least four weeks before they were required by the fabricator. It was consequently decided that April 15 would be the completion date of all of the hull drawings, and that January 5 would be assumed as the date for starting, or an allowance of one hundred days to turn out the fabricated drawings complete. A complete analysis of the drawings was then made. It must be understood that all of the values in this analysis are arbitrary and that the schedule was adjusted many times before the drawings were complete. It served, however, the very good purpose of enabling the drawing room to anticipate delays which would have held up production at the fabricators, and the "value" assigned to the various classes of material was proven fairly accurate. This "value" multiplied by the number of days allowed to complete the job will give the number of days in which that particular class should be completed. Where the class is split among two or more drawings, the time element is in direct proportion to the weight.

Referring to the analysis of drawings, the first line covers the flat plate keel, which lies wholly in class A. The fabricator should produce seven plates with the necessary butt straps for each ship. It should be possible to cover these seven plates with two drawings; the plates and straps will weigh approximately 20 tons. Referring to the classification schedule, we find that the 520 tons of this class A, to be produced, should be turned out by the drawing room in approximately (.279 $\times$ 100 days) 28 days; 20 tons is .038 of 520 tons. Accordingly, this lot should be drawn up complete in .038 of 28 days, or 1 day. As there will be two drawings, two draftsmen, or the equivalent of two draftsmen, will be required with a checker, and this will require three man days. This process is followed for each class, and, as a safety check, the final completion date for each group of drawings or plans is put in five days ahead of the date of delivery to the fabricator. A record was made of the date each group was started, but this was not continued, as the chief draftsman's plan-record carried this information in detail for each drawing. Summing up the analysis of drawings, we find that we will have to make approximately 97 drawing to cover the work to be done by the fabricator. This will require 900 man days, or a daily average of nine draftsmen, employed only on plans to go to the fabricator.

The following of this plan was not all smooth sailing. These estimates, however, gave us a tangible beginning and end, and enabled us to so classify our drawing room force that the permanent organization was not only not disturbed but was kept on work with which it was thoroughly familiar, and a new organization, of a temporary nature, was built up of "bridge builders" and "structural men" who were not trying to qualify as ship draftsmen. Incidentally, "overtime" was under absolute control.

The machinery draftsmen carried their work parallel with the hull draftsmen. But as their plans and layouts were required at times which were controlled by the handling equipment of the yard and method of erection, no effort was made to control their output except to secure completion of their plans prior to the date of starting installation of the equipment which they covered. Drafts-

ANALYSIS OF PLANS FOR FABRICATOR

	Class	No. Item	Drawing	Weight Tons	Estimated Days	No. Men	No. Checkers	Man Days	Must Start	Must Complete	Started
Keel, flat plate....	A	7	2	20	1	2	1	3	2/8	2/20	1/5
Keel, vertical.....	F	8	6	22	3	6	2	24			
Bot. shell plating.	A	50	7	87	5	7	2	45	3/10	3/25	
Floors	D	45	5	85	11	5	1	66			
	E	67	5	90	13	5	2	91	3/3	3/30	
	L	17	9	40	6	9	2	66			
Tank top........	A	67	5	115							
	B	22		28	9	5	1	54	3/20	3/9	
	C	16	3	6	7	3	1	4			
	K	..	5	16	2	5	2	14			
Bulkheads.......	A	35	1	55							
	B	15	8	25	10	9	2	110	2/8	3/15	
	C	26		10							
	J	80		25							
Frames	G	9	1	10	3	1	..	3			
	I	50	3	86	6	3	1	24	2/25	3/19	
	K	4	2	6	2	1	..	2			
Deck beams......	J	136	7	90	7	7	2	63	3/3	3/23	
	K	...		17							
Shell plating.....	A	49	6	108	5	5	1	30	3/9	3/25	
	M	8	1	20	2	1	..	2			
Decks	A	85	7	90	..	7	2	..			
	B	53	..	60	8	..	..	72	3/10	4/1	
	H	5	2	20	2	2	..	4			
Houses	A	..	..	45							
	B	..	..	90							
	C	..	12	4	15	12	3	225	3/3	4/10	
	I	..	..	9							
	J	..	..	40							
	K	..	..	10							
Totals.......			97			95	25	902			

men in shipyard work design, as a rule, from a book of specifications, and delays due to changes in equipment frequently hold back delivery of necessary drawings to the shop and yard, drawings for which workmen are waiting.

A schedule covering machinery equipment and outfit will be covered in a future number of this publication.

Salvaging the Steamship St. Paul*

Methods Used in Turning Vessel—Character of Problems Solved—Placing a Patch Under Difficulties

BY CHARLES M. HORTON

TWENTY-TWO divers and over two hundred laboring men, not including the individual crews attached to the eight huge derricks which were brought into the work, were engaged on the job of salvaging the steamship *St. Paul*, a vessel 535 feet long, 63 feet beam, 26.8 feet depth, and with a gross tonnage of 11,629, which recently foundered in the Hudson River between docks 60 and 61, New York City. The Merritt & Chapman Derrick and Wrecking Company, 17 Battery Place, New York, had the work in charge. The boat lay about fifty feet distant from Pier 61, with the lower side of her submerged open decks in fifteen feet of mud—a mass of tangled and broken rigging. In turning over, she had struck her masts and funnels against the pier sheds, and when the salvors came her foremast lay broken off close to the sun deck. Interiorly, a notable feature was that the 85 percent magnesia used in boiler and pipe coverings had successfully withstood the protracted submersion in water and grime and slime in the vessel.

In putting through the work, various clever makeshifts were found expedient. Ventilators were used as connections with the lower decks, through which blower pipes were inserted and air blasts passed down to drive out the mud. A number of steam mains were laid along the upper side of the vessel and tapped off at convenient places to serve the steam pumps installed along the side. Electric wires were strung to light the operations of the workmen below. A barge moored alongside the ship served as machine shop and power plant. Its equipment included a portable boiler, a large air compressor, a small air compressor, a water tank, a drill press, a power saw, some pipe cutting tools, an emery wheel, a telephone, a forge and all necessary hand tools.

The work of salvaging resolved itself into three major operations. The first operation consisted of placing rigging and cables and pontoons with which to roll the vessel high and free of the mud. Speaking of mud, by the way, it is estimated that in the lower part of the vessel and along the alleyways on the port side of the decks the ship contained over two thousand tons of mud. Lodgments of mud in the vessel and quantities outside, which constantly gained entrance, proved the one stubborn obstacle against the work of salvaging. The mud between Pier 61 and the wreck alone was some fourteen feet high in places along the decks. Dredging was, accordingly, necessary between the ship and the pier before it was

* Illustrations by courtesy of Merritt & Chapman Derrick and Wrecking Company.

Fig. 1.—Showing "A" Frames and Pumps at Work in the First Rolling Effort

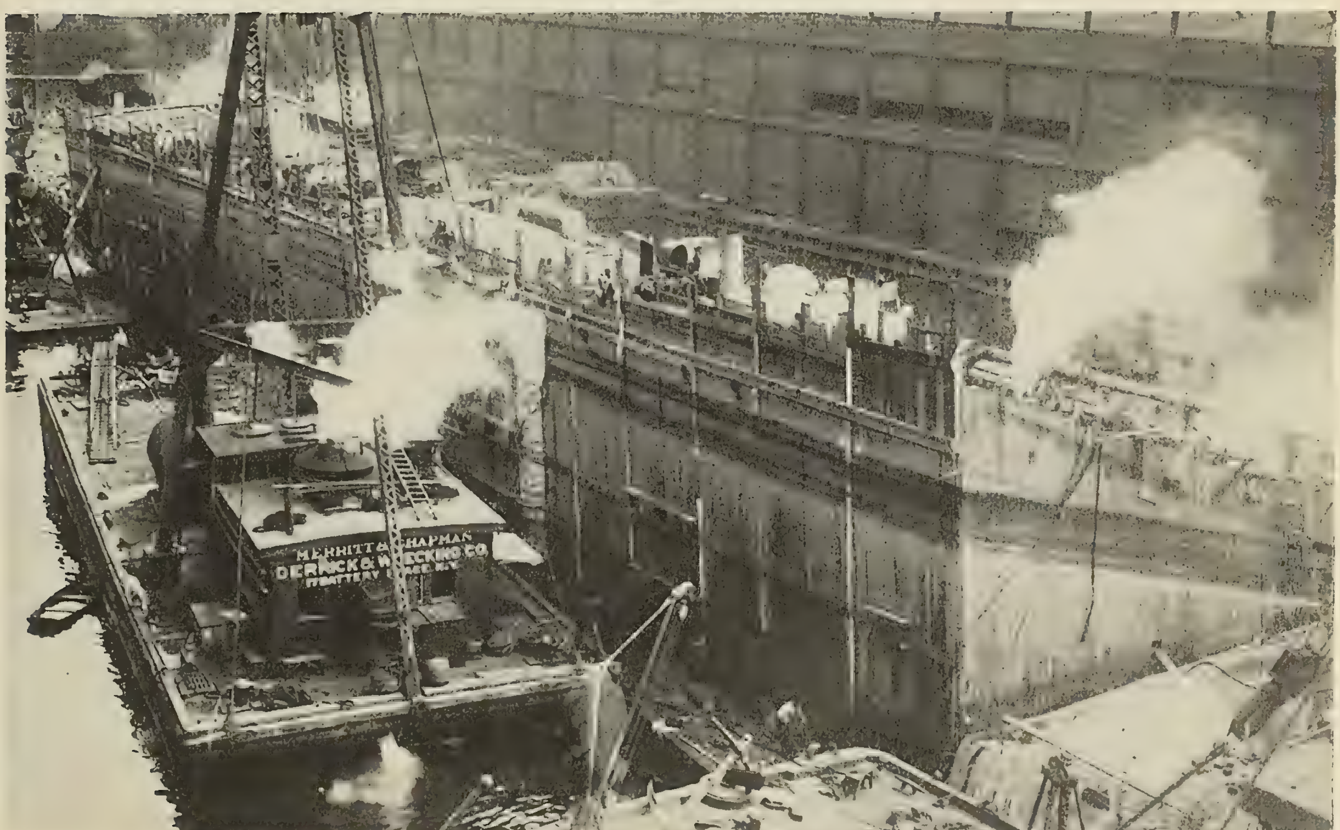


Fig. 2.—The Main Cofferdam Was 360 Feet Long on the Port Side and 290 Feet Long on the Starboard Side

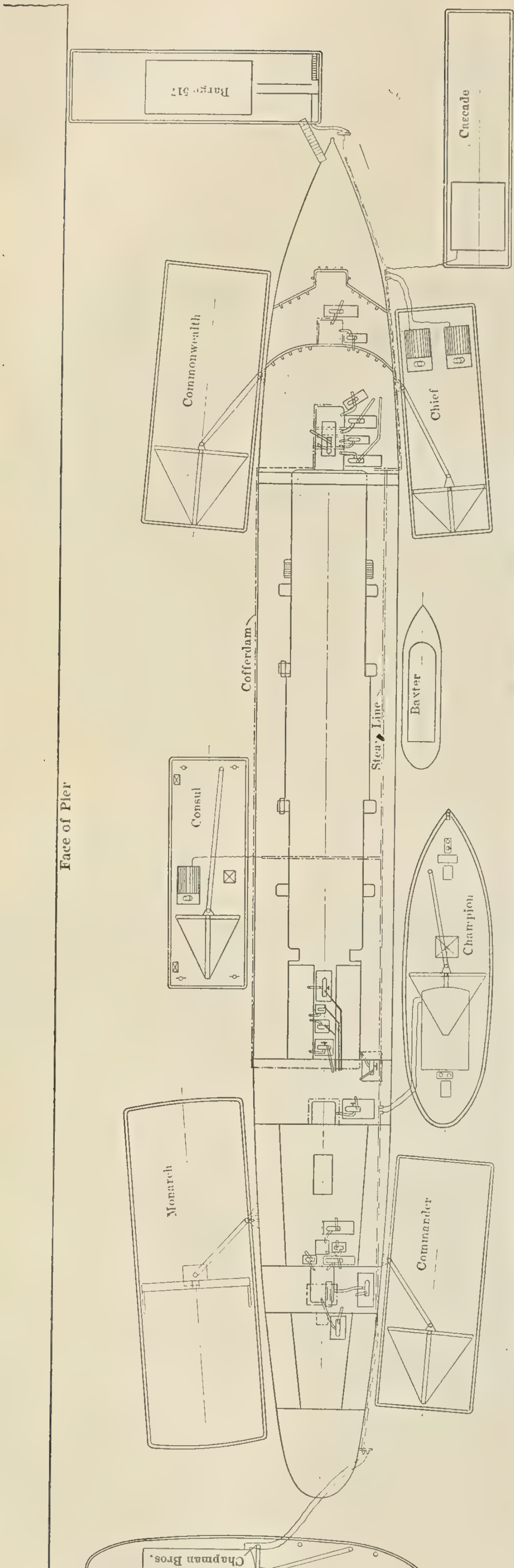


Fig. 3.—Showing Position of *St. Paul* in Relation to the Pier, Together with Position of Derricks in Relation to Vessel

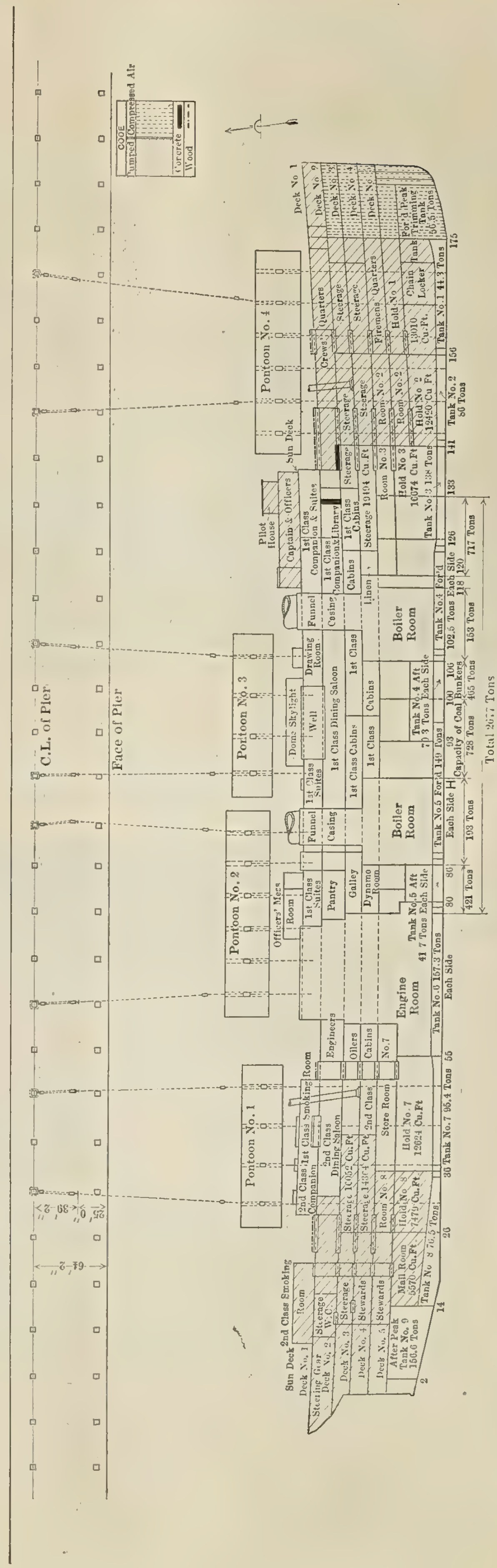


Fig. 4.—Diagram of Vessel as She Lay Before Arrival of Salvors, Showing Areas Which Were Pumped Out and Partitions of Wood and Concrete Which Were Used in Closing

Fig. 5.—View of the Vessel as She Looked the Second Day After Sinking

possible for the divers to make their way to the port side and along the keel in their work of establishing connections. Cables were strung from the vessel to a point eighty feet below water between Piers 59 and 60, where further dredging was done to accommodate twenty-one concrete anchors, each ten tons in weight.

The pontoons exerted approximately 1,200 tons lift. Also, twenty-one hoisting engines were installed along the edge of Pier 60, to pull on the tackles attached between the "A" frames made fast to the ship's side and concrete anchors in the next slip exerting an 840-ton pull. Checking wires were then led around and under the ship and made fast with tackles to Pier 61. This was done in order that the vessel be properly stayed against a possible sliding to the southward while being rolled. Another preparation was the installation of pumps along the forward and aft ends of the ship by which the mud and water were to be pumped out of the forward part of the ship, the pilot house, the captain's and officers' rooms, the after end of the ship and the smoking room aft, all of which had been made tight by divers. With these and other preparations completed, the work of actually lifting and rolling the vessel began.

The pumping and pulling continued for six days. The first day the ship was rolled to a point some thirty-six degrees toward an even keel, and thereafter a gain of a little less than two degrees each day was made, until, with the end of the sixth day, with the vessel lying some twenty-seven degrees from the perpendicular, the work of rolling was temporarily suspended and preparations undertaken for the second operation. This consisted of two steps—taking off the pontoons and closing the entire vessel. The former was accomplished without difficulty, but the latter compelled the use of some novel engineering measures in order effectively to guard against a return into the hold of mud and water.

This work, which meant the closing of the entire vessel, was done, of course, by divers. Scuppers, water-closet openings, garbage hoppers and chutes, bathtub openings, and the like, were sought out by these men and one after another effectively sealed. In more than one instance the divers had to grope and dig their way through mud inside the vessel in order to gain access to the portholes and close them. One very effective piece of work was accomplished when a diver placed a patch over an ash port fifty-three feet below waterline. The patch used was an iron plate twenty-one inches by twenty-four inches, oval in shape. In the work of placing this, sixteen bolts were screwed up with marked neatness. It was completed in less than two days. Another novel stunt was accomplished with concrete, where a slab over a foot thick was used to seal over two of the hatchways. With this done and all openings and ports, of which latter there were over a hundred, closed, the second stage of the work was commenced.

This was a continuation of the pumping and rolling operations, but with the additional advantage of derricks lifting on the chains previously attached to the pontoons. One derrick lifted on the chains attached to the forward pontoon and another lifted on the chains attached to the after pontoon. In this way the vessel was brought from twenty-seven degrees to sixteen degrees from the vertical. In this work also the pull on the "A" frames, exerted by means of cables attached to the hoisting engines on Pier 60, was continued, as was also the work of pumping out, both of the ship and the cofferdams built on the ship.

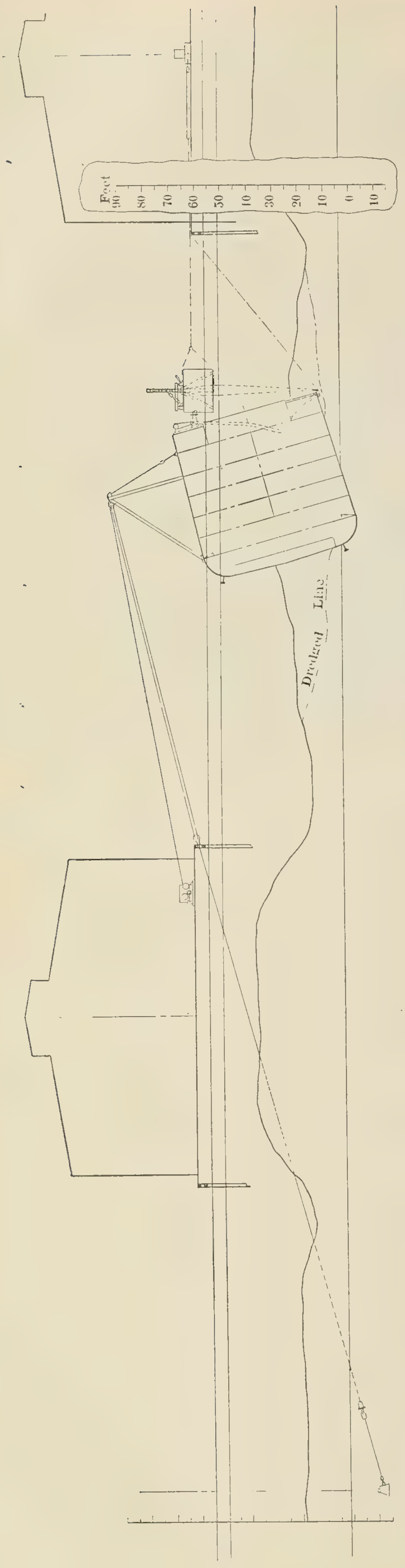


Fig. 6.—Diagram Showing Position of *St. Paul* and the Way in Which Anchors and Cables and Hoists Were Placed for Lifting and Turning the Vessel

There were a number of cofferdams used, one embracing hatch No. 1, and with one each around hatches Nos. 2 and 3. However, these last were connected with and made an integral part of the main cofferdam, which was 360 feet long on the port side and over 290 feet long on the starboard side, and which extended from a point forward of the bridge to a point about six feet aft of the after end of the engine room. Similarly, there were cofferdams about hatches Nos. 4, 5 and 6.

One of the difficulties met with in pumping the *St. Paul* was the drainage of the large number of compartments. Dynamite was used to break through some of the restraining walls, but the most satisfactory results were obtained by the use of an underwater cutting device invented by two members of the salvage force and here used for the first time. Twelve holes were cut by this method to allow the water within the ship to drain to the large pumps.

After bringing the vessel to a sixteen-degree list, preparations for entering upon the third, and last, stage were begun. The "A" frames were removed and ballast, which was brought on lighters to the extent of six hundred tons of rock, was placed aboard the vessel. Two hundred and fifty tons of this were set into hatch No. 4—through a chute and in such a position that the weight lay at a point amidships to a point as far outward along the starboard side as it proved possible to reach; another hundred tons were placed in hatch No. 2 in the same manner, and an additional two hundred and fifty tons were set into the forward starboard coal bunker, loaded through a coal chute which had been reinforced for this purpose. The job was now in shape for the third operation—the floating of the ship.

It consisted primarily in pumping out the entire vessel. In order to do this without danger, the ship had to be steadied also. The work of steadying was done with the aid of four large derricks, two on the starboard side and two on the port side. Five hours from the moment when the pumps were started the vessel righted herself to a position about four degrees from the vertical, and she was completely afloat, both forward and aft. The pumping operations were continued for a period of two weeks, although the ship continued with this four-degree list, owing to the fact that everything movable within had fallen over to the port side. Nevertheless, during this time she continued to float higher, because of the steady removal of weights and sections of cofferdam by the workmen, as well as the continued flow of water and mud which was being lifted out of her port side. The workmen followed the work down as rapidly as the changing conditions would permit, cleaning out deck two, and then three, and then four, until it was seen that under the circumstances the vessel would heel permanently to port. To overcome this, some three hundred and five tons of ballast, in addition to the amount already placed there, were put into hatches Nos. 1 and 2, which brought the ship to an even keel.

Altogether, the work of salvaging was very commendably brought about. Much care and foresight was needed in order successfully to prepare for the work, to say nothing of the engineering skill which was needed to bring the vessel to an even keel. Not the least of this was the cement patches over the hatchways, which are indicated in the illustration, and which, while known to have been placed under almost insurmountable obstacles, yet bore evidence, after the vessel was raised, of having been a most complete and correct job of closing. The credit for this and other details, as well as the work of salvaging the vessel as a whole, goes to Captain I. M. Tooker, who superintended the job, with Mr. Ralph E. Chapman acting in the capacity of salvage engineer.

Conservation and Stabilization of Man Power in Shipyard*

An appeal to all shipyards to conserve and stabilize their labor to meet the growing labor scarcity has been issued by the United States Shipping Board Emergency Fleet Corporation. To handle the situation caused by the calling of men into military service, it has been recommended that each shipyard work toward the establishment of centralized employment departments.

The necessity of conserving man power is obvious. An inventory of the working forces in the shipyards will reveal that, while the scarcity of men may seriously aggravate the industrial situation, in many cases it is by no means the greatest handicap to production. The handicap frequently lies in handling the problems related to obtaining, choosing and retaining employees without careful plan or thought. To overcome this situation and thereby often solve the shipyard's production difficulties, the shipyard should have definite means of knowing how to find competent men, either outside or within the yard; it should hire men carefully, with due regard for their qualifications and ability, and assign them to tasks which are within their capacity and to which they are well suited, and it should surround them with such good facilities for living and such incentive to effort that once placed on a job they cannot be readily induced to leave. That is stabilization.

Functions of Employment Department

Realizing the necessity not only of having enough labor available, but of stabilizing it, the president recently issued a statement centralizing all activities for recruiting unskilled labor for war industries in the United States Employment Service. In this way the President has called the nation to the aid of industry, and industry must respond in the same spirit as the nation offers its aid. Not only to increase production by stabilizing labor, but to afford the government proper assistance in this programme, each yard should establish a single centralized channel through which all workers are secured and with which the shipyard officials, on the one hand, and the government recruiting officers on the other, can deal.

The functions of a properly constituted employment department may be broadly and briefly defined as follows: *To develop sources of labor supply that will provide a sufficient number of competent employees; to select and place employees in the jobs to which they are best fitted; to control questions of transfer, promotion, discharge, and other adjustments affecting the employee relationships in the plant, and to develop within the organization plans for mutual helpfulness that will promote a spirit of genuine co-operation and understanding between the management and the employees.*

Qualifications of the Employment Manager

An employment manager should be a capable, executive, broad-minded, fair and square, and of sympathetic temperament, in order that he may be easily approached by any man in the organization. He should be ready at all times to listen to their complaints, troubles or suggestions, and big enough to solve their problems and keep them happy and satisfied with their work. A man in this position needs to possess courtesy, even temper, patience, and ability to be a good mixer. Furthermore, he should have sufficient poise and dignity to sit at a council table with other executives and heads of departments and discuss current plant problems intelligently.

The employment management branch of the industrial service section is training men as employment managers for the shipyards. Besides the preliminary training at various universities, these men receive the benefit of actual shipyard experience under the direction of the Emergency Fleet Corporation. Plants interested in securing an employment manager may communicate directly with the industrial service section of the Emergency Fleet Corporation. When the employment manager is chosen, his policy and plan must be properly introduced and explained to the foreman and superintendents, and his relation to the entire shipyard organization be clearly established. It is essential that the necessity for the new department be demonstrated. This matter can be effectively handled by showing the effect of labor turnover—what it means to the company to hire and break in a worker under the old scheme, with the lessened production, accidents, cost of instruction, spoiled work and other factors involved, and what an expensive mistake it is to lose this man just as he becomes a real producer. The cost to the individual workers who lose time and money in passing from job to job and in moving their homes from place to place may also be cited. This shifting about leads to industrial unrest and decreased production. Out of this situation the need has clearly arisen for some department to devote its exclusive attention to finding means for improving these conditions. The employment manager is trained to cope with the situation; the centralized employment departments supply the necessary organization.

Need for Technical Men

Together with this, though not directly in line with it, a strong appeal is made to the naval architects and marine engineers who are now engaged in non-essential work to take up positions in the shipyards. The number of naval architects, marine engineers, hull draftsmen, engine draftsmen and other high-grade, technically trained men wanted by the leading shipyards at the present time is approximately 325. At present, practically all marine engineers and naval architects are engaged. The shipbuilders are therefore desirous of securing structural engineers, civil, mechanical or architectural engineers who could fit into this special field. Several of the yards are using such engineers on the construction of hulls or in the installation of machinery.

Offers Excellent Opportunities

This field of actual construction offers excellent opportunities for young technically trained men. Those qualified are urged to get in touch with the situation through Supervisor Frank P. McKibben, United States Shipping Board, Emergency Fleet Corporation, Philadelphia.

As a further effort to meet the situation, a series of intensive training courses (each of ten weeks' duration) in naval architecture and shipbuilding are being organized under the Emergency Fleet Corporation at the Massachusetts Institute of Technology, Cambridge, Mass. The first section matriculated September 30, 1918.

Requirements for Enrollment

Applicants for enrollment in this school should be graduates of civil, mechanical, electrical, mining or architectural engineering courses, if not graduates, or should have the equivalent of such training. Men who have completed their junior year in college in any engineering course mentioned will be accepted if the school is not previously filled with graduates or the equivalent. Applications should be sent to the Education and Training Section, Emergency Fleet Corporation, Philadelphia, Pa. Those men especially qualified for the work should get into the game at once.

* From the handbook on employment management prepared by the Industrial Relations Group of the United States Shipping Board.

Analysis of Gas and Gasoline High-Speed Engine Design*—I

Comparisons and Analysis of the Two Fuels—
Diesel Engine—How to Hold Detonations in Check

BY HARRY R. RICARDO, B. A.

THE author proposes to examine and set out some of the features of high-speed engine design, and to indicate some of the points upon which the designers of these engines have concentrated their attention. In the first place, most of these smaller high-speed engines are designed to run on gasoline (petrol), and it is sometimes argued that the conditions under which they operate are totally different from those that apply to the larger and heavier types of internal combustion engines. This is true, but to a limited extent only, for, generally speaking, what applies to a gasoline (petrol) engine will, with certain reservations, apply equally to a gas or Diesel engine, while, so far as mechanical conditions are concerned, the problems to be faced are practically identical in either case.

During the course of the war the development of light high-speed engines has progressed with remarkable rapidity and has received a very great impetus from the fact that a large number of well-trained and scientific men have devoted their attention to it, and, taking advantage of the many excellent mechanical features already to be found in these designs, have also directed their development along sound scientific lines.

Advantages and Disadvantages of Gas and Gasoline

In answer to any imputation as to their lack of theoretical knowledge, the designers of high-speed gasoline (petrol) engines almost invariably used to reply with the retort that, besides being able to run at much higher piston speeds, their engines could use higher mean pressures, and showed a thermal efficiency equal to and, in some cases, relatively higher than the average gas engine. This retort was generally true, and the author proposes, before proceeding further, to devote a short time to comparing the advantages and disadvantages of, say, gas and gasoline (petrol) as a fuel.

In the first instance, other things being equal, the power output of any internal combustion engine depends upon the weight of oxygen that can be taken into the cylinder and burnt in unit time. Here gasoline (petrol) scores a very decided advantage for three reasons:

1. In order to consume the whole of the oxygen present in the cylinder, the volume of gasoline (petrol) vapor required is only slightly over 2 percent, while that of gas is nearly 20 percent, consequently the volume of oxygen dealt with in the case of gasoline is 18 percent greater.

2. Owing to the latent heat of evaporation of gasoline (petrol) the temperature of the working fluid is reduced both before and during its entry to the cylinder. Hence a slightly greater weight is taken in for a given volume.

3. After combustion the specific volume of the working fluid consisting of an air-gasoline (petrol) mixture is increased by about 4 to 5 percent, while that of an air-gas mixture is reduced by about 3 percent.

On these three grounds alone gasoline (petrol) scores heavily, for not only does the fuel itself displace less oxygen, but it also withdraws heat from the charge, and thereby increases its weight, while finally the actual volume of the charge after combustion is greater than before.

On the other hand, gasoline (petrol) labors under two serious disadvantages:

1. Owing to its very limited range of inflammability, it is not possible, as with gas, to work with a weak mixture. In fact, the mixture giving complete combustion is almost identical with that giving maximum economy, for if the mixture be weakened to any appreciable extent below that required to give complete combustion, inflammation is seriously delayed and continues throughout the expansion stroke. As a result of this peculiarity, it is not possible by ordinary means to reduce the flame temperature, and, since the efficiency of any engine, relative to the air cycle efficiency, is dependent upon flame temperature (owing both to direct loss of heat and to the change in specific heat at high temperature), it follows that from this point of view a gasoline (petrol) engine can only operate under the most disadvantageous conditions.

2. Owing to its low ignition temperature and to the high proportion of hydrogen present in the fuel, it is not possible to work with so high a compression pressure. In practice the limiting compression ratio that can be used for gasoline (petrol) is about 5:1 (depending, of course, upon a number of subsidiary conditions). This gives an air cycle efficiency of 47.5 percent with gas; on the other hand, it is possible to use a compression ratio as high as 6.25:1, giving an air cycle efficiency of 52 percent.

Advantages of the Diesel Engine

We will consider next the case of the Diesel engine. This engine has the following advantages in its favor: (1) No fuel is taken into the cylinder until after the end of compression, hence no oxygen is displaced and the greatest possible volume is taken in. (2) The combustion of crude oil and air also results in an increase in the specific volume as in the case of gasoline (petrol). (3) Additional air compressed separately is nearly always admitted to the cylinder along with the fuel. The increase in mean pressure due to the presence of this additional air is invariably credited to the indicated power of the engine. This gives the Diesel engine an apparent indicated power which is altogether illusive. In common justice, the indicated horsepower absorbed by the compressor should be deducted from that developed in the cylinder, before any comparison is made between it and other internal combustion engines.

There are so many variables connected with the Diesel cycle that the author has not attempted to show a comparative mean pressure and efficiency curve. In the first place the air cycle efficiency itself varies with the flame temperature. Again, the proportion of air admitted along with the fuel has a powerful influence both on the mean pressure and efficiency, and that proportion is a variable quantity. Thirdly, the highest mean pressure attainable is governed not so much by consideration as to the quan-

* Extract of paper read before the Northeast Coast Institution of Engineers and Shipbuilders.

tity of oxygen present in the cylinder, but rather by the quantity that can be brought in contact with the particles of fuel and burnt in the short time available.

From the above figures it is clear that, while with gasoline (petrol) it is possible to obtain an indicated mean pressure of 146 pounds per square inch under extreme conditions, or 136 pounds per square inch under economical conditions, with gas it is not possible to obtain a higher mean pressure than about 110 pounds per square inch, even when working with the richest possible mixture. On the other hand, with gasoline (petrol) it is not possible under any normal circumstances to obtain an indicated thermal efficiency of more than 33 percent. With gas it is possible to obtain as high an efficiency as 37.5 percent when working with a weak mixture and a low-flame temperature. The best modern gasoline (petrol) engines, such as those employed for aircraft work, do actually realize an indicated thermal efficiency of over 32 percent, while gas engines have occasionally shown as high an efficiency as 37 percent, showing that in both cases there is not much scope for improvement so long as the usual cycle is adhered to. It is obvious, however, that the thermal efficiency of either type of engine, and more particularly of the gasoline (petrol) engine, could be greatly increased by working with a lower flame temperature; theoretically, the efficiency rises as the flame temperature is reduced, until at the point of no heat supply the efficiency will be equal to the air cycle, but the power will be nil.

Analogy of the Paper Bag

While the author has stated that, owing to the very limited range of inflammability of gasoline (petrol) and air mixtures, it is not possible by ordinary means to work with a weak mixture, and hence at a lower flame temperature; this, of course, applies only so long as the working fluid is homogeneous. It is interesting to consider what would happen if into a cylinder full of air there were inserted a paper bag containing a small charge of air-gasoline (petrol) mixture of normal density, and that at the end of compression stroke this mixture were ignited and the bag burst so that its contents, already fully aflame, were discharged into the large excess of air present. Under these circumstances the effect would be equivalent to working with an extremely weak mixture: the mean flame temperature would be very low and the efficiency very high. Some such condition as this can be reproduced in a practical form by means of stratification, and the indicator diagram, taken by means of an optical indicator from one of the author's high-speed experimental engines, shows the results obtained. When running under these conditions, indicated thermal efficiency was no less than 38 percent, with a mean pressure of 23 pounds per square inch.

Losses Due to Vaporization

While comparing the two fuels, gas and gasoline (petrol), there are two other points which need consideration. Gasoline (petrol) is a liquid, and before it can be used in the engine it must be vaporized, or at least finely pulverized. This entails a certain loss, though a very small one, and it also imposes certain restrictions in the design, especially in the design of the pipework, which must be carried out in such a manner that the pulverized and partially vaporized particles of gasoline (petrol) are kept in rapid and, as far as possible, continuous motion, in order to prevent them from precipitating on the walls of the pipework. The other peculiarity of gasoline (petrol) is its readiness to detonate on account of its chemical instability and of the large proportion of hydrogen present. Such detonation is generally referred to as "pinking," and often, but quite erroneously, as pre-ignition. Pre-ignition means, of course, self-ignition of the fuel before the end of the compression stroke. Detonation, on the other hand, is merely extremely rapid burning, so rapid, indeed, as to cause local rises of pressure, which spring the walls of the cylinder and cause them to vibrate as though they had been struck by a hammer. What actually occurs appears to be this: A portion of the working fluid in the neighborhood of the sparking plugs is ignited and proceeds to burn in the usual manner, but so rapidly that it compresses before it the rest of the unburnt charge, until the heat of compression is such that the unburnt residue ignites spontaneously and suddenly throughout its whole bulk; in other words, flame propagation proceeds normally at first and then suddenly changes and becomes practically instantaneous. This tendency to detonate is very tiresome, and it, of course, increases as the compression ratio is increased and the temperature and pressure of the working fluid are raised by compression. It is, as might be expected, dependent to a considerable extent upon the shape of the combustion chamber and the position of the igniter, and it also depends upon the density of the fuel; the denser the gasoline (petrol), the greater the tendency to detonate, presumably because the heavier fractions are chemically less stable than the lighter ones. It becomes particularly troublesome when working with paraffin kerosene. Such detonation is checked as follows:

1. By reducing the temperature and pressure of compression by the admission of water or other such means.

2. By increasing the proportion of carbon in the fuel by mixing it with hydrocarbons of the aromatic series, such as solvent naptha, metaxylene, or benzol.

3. By introducing inert gases, and preferably by adding gases containing carbon such as carbon dioxide. In practice this can be accomplished by readmitting cooled exhaust gases, a method frequently adopted in the case of large gas engines using coke oven gas, in which the proportion of hydrogen is large, and the same trouble arises.

This tendency to detonate compels the use of a lower compression ratio than would otherwise be necessary and is a serious handicap to the gasoline (petrol) engine.

(To be continued)

American Harbor Facilities Now in the Lead

Only a few years ago it was customary to use pictures and drawings of foreign ports, terminals and terminal facilities to illustrate the most modern construction and equipment. The passing of the old régime was silently recorded by the illustrations used in the address of H. McL. Harding at the monthly meeting of the Society of Terminal Engineers, September 24, at the United Engineering Society's Building, New York.

In this address every description, photograph, design, plan and operating condition referred to American port installations and practices, since these may now be considered the most modern examples of permanent quay walls, fireproof and decay-resisting construction, and of up-to-date mechanical facilities. These illustrations clearly demonstrated that the American terminals were equal and even superior to the best in Europe. Among the mechanical appliances shown were the half-arch traveling gantry jib cranes for discharging and loading vessels, also the internal traveling loop cranes for assorting, distributing and high-tiering. The latter equipment eliminates congestion at the point of freight deposition.

America may now be said to lead the world in port and terminal facilities. It is no longer necessary to refer to the terminals of the Rhine or the Rhine waterways as examples for the United States to follow.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Salvaging Torpedoed Ships

Unusual feats of ship surgery are at present being carried out by the Admiralty Salvage Department of the United Kingdom, which has grown from a nucleus of private enterprise to a big organization capable of tackling any ship repair job. A concrete idea of the incalculable value of salvaging is best gained from a study of some of the interesting details of the work of this department.

One of the largest tank steamers had been mined. The cargo consisted largely of benzine. It immediately caught fire. A heavy explosion flooded the decks with burning oil. With the wind aft, the blaze at first kept forward. The magazine went up and there were several explosions of gas from the petrol. As the wind changed the after parts of the ship took fire. Most persons would consider the case hopeless. Not so. The vessel was scuttled by forty shots fired into her, thus extinguishing the fire. Divers then went down, plugged the shot holes and closed other apertures. On being pumped out the vessel floated and was forthwith taken to a repairing port.

Another salvage may be sighted to show the value of the submersible electric pump. A ship which carried a cargo (mostly foodstuffs) valued at over $14,250,000 (£3,000,000) was torpedoed. The torpedo made a hole in the ship's side about forty feet long by twenty-eight feet deep. She was taken in tow by rescue ships, but went down before she could be suitably beached. At low tide, for about two hours, the shelter deck—fifty-eight feet from the bottom of the ship—was just awash. No ordinary pumping power would have served the need. The new type of pump enabled stoke-hold, engine room and after-holds to be pumped out so that cargo could be discharged and the vessel brought up further on the beach. Here the lightening process was continued until the vessel was floated and taken into dock with practically all her cargo saved.

One salvage vessel has fallen a victim to submarine attack, but the department's percentage of loss, both of life and plant, has been very small. The number of ships of the mercantile marine actually salvaged by the department in the two years from 1915 to 1917 was, it seems, 260. All were vessels of pretty large tonnage. For the present year, the monthly totals of such vessels salvaged were: In January, 14; in February, 41; in March, 37; in April, 36, and in May, 19. Thus the department has saved 407 important vessels of the mercantile marine. The larger figures of the latter period were due not to increased enemy activity, but to improved salvage methods. The total does not include vessels restored outside of home waters. It is impossible, of course, to raise the *Lusitania* and other vessels sunk in deep water.

The department has been at work on many ships at one time. For torpedoed damage, a standardized patch has been used which, when projecting parts of injured plates have been cut away, can quickly be bolted on. It is interesting to note that, after being temporarily repaired following a torpedo attack, two vessels were torpedoed a second time abreast of the first injury. In each case the standardized patch held firmly against the shock and the vessel was saved.

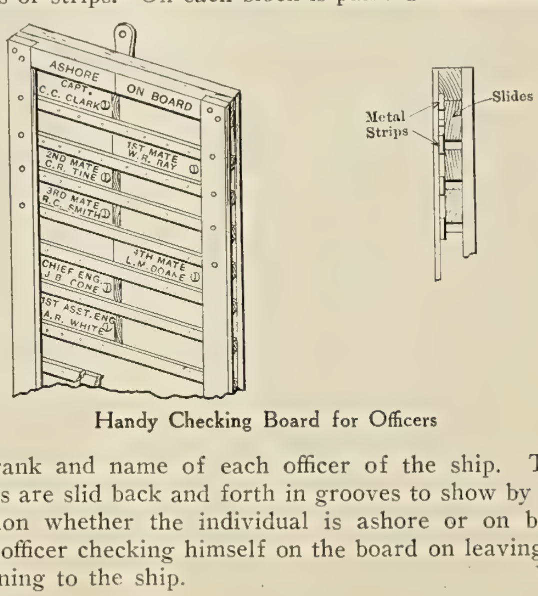
The salvage of a large government collier illustrates the recent advance made in salvage science. This ship, when partly laden, was sunk by collision in twelve fathoms of water, where she obstructed an important channel and anchorage. She weighed 3,500 tons. It had hitherto been believed that no vessel of more than 1,500 tons could be raised by wire ropes. After a great deal of sweeping work with salvage vessel, sixteen 9-inch wire ropes were placed in position under the bottom and brought up to four lifting craft placed over the wreck. Water was emptied from the ballast tanks and the vessel's weight thereby reduced to 2,750 tons. She was then lifted and carried a mile inshore clear of the anchorage. Following other lifts, this vessel was beached and patched, and, after being permanently repaired, she embarked on a new career of useful voyages.

Finally, a word should be said about the risks run by the divers, particularly those resulting from gases generated by decomposed vegetables and meat in the holds of the sunken vessels. Several deaths have resulted from this cause. Decomposing grain, it seems, produces sulphureted hydrogen, which occasions semi-blindness and violent sickness. An English chemist has found a preparation which, when sprayed on a rotting cargo, immediately kills the gases and thereby enables the men to carry on their work in safety.

Liverpool, England. MARK MEREDITH.

Handy Checking Board

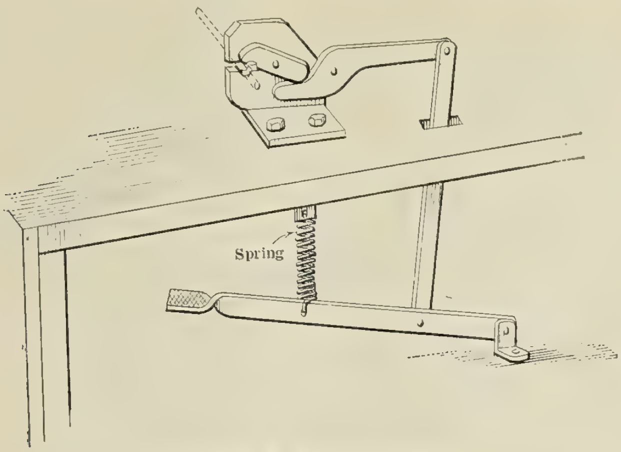
This is not a new or original idea of the writer, but it is one that I have not seen passed on in the pages of MARINE ENGINEERING, so that a sketch of this board will be of interest to the readers. It consists of several sliding blocks or strips. On each block is painted in small letters the rank and name of each officer of the ship. These blocks are slid back and forth in grooves to show by their position whether the individual is ashore or on board, each officer checking himself on the board on leaving and returning to the ship. W.



Handy Checking Board for Officers

Home Made Rod Shear

For making pins and shearing small drill rod, the boys made a small bench shear, a sketch of which is shown herewith. The frame was made from a piece of ½-inch

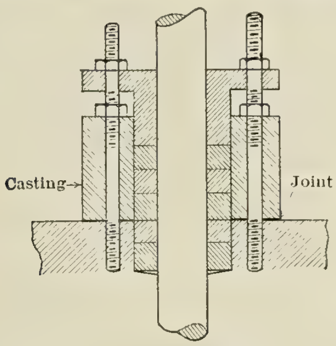


Drill Rod Shear Machine

boiler plate, as were also the levers and cutter. No dimensions are given, nor does a detailed description seem needed, as those to whom the idea might appeal will make it to suit their needs. ASSISTANT.

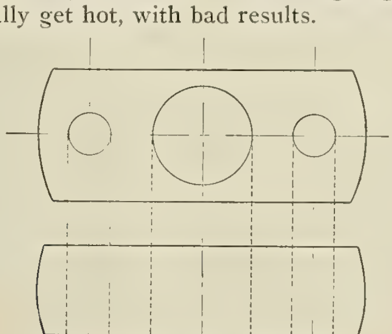
Glands

Sometimes the glands on pumps and engines are found, by experience, to be a little too shallow, with the result that oil, water, or steam, as the case may be, leaks out. With a gland holding only, say, two turns of packing,



Deep Gland to Stop Leaks

screwing the gland up tight to stop leaks will, in many cases, stop a pump, and on a fast running engine the rod will eventually get hot, with bad results.



Block Casting for Extending Stuffing Box

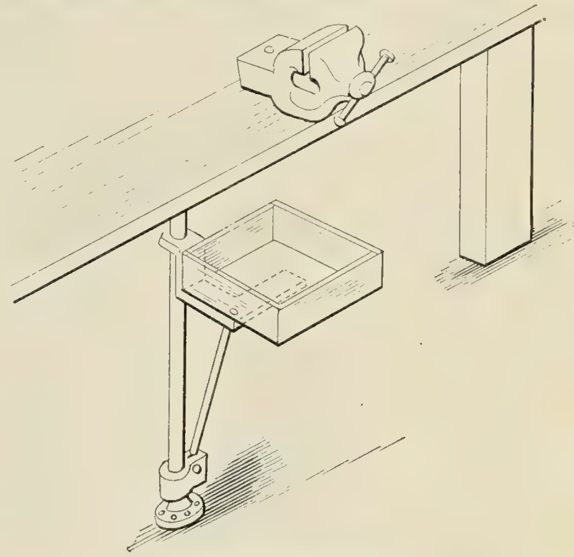
By deepening the gland and having five or six turns of soft packing in, instead of two, less pressure can be put on the gland nuts. In this way the leak may be stopped, and the thing will be a benefit in many ways. If there is enough clearance between the crosshead and the gland, a casting can be made two or three inches deep and jointed down by two long studs and nuts, as shown, so that the center hole in the casting is really an extended stuffing box, being the same diameter as the stuffing box. Longer studs will have to be fitted to make up for the extra depth of stuffing box.

Victoria, B. C. EDMUND B. DELL.

Quickly Accessible Drawer

This somewhat odd but very handy bench drawer has been installed under the writer's workbench. It is quite simple, as may be seen from the sketch, and can be made from odd stock found about the shop.

The upright or stanchion is made of pipe or could be



Swinging Bench Drawers

made of old boiler tube; the drawer bracket was made of ½ by 2-inch flat stock bend to the form indicated, the drawer itself being made of wood.

The real value of such a drawer lies in its quick accessibility and in the ease with which its contents can be seen at a glance. C. H. WILLEY.

Emergency Repairs to Main Check Valve Spindle

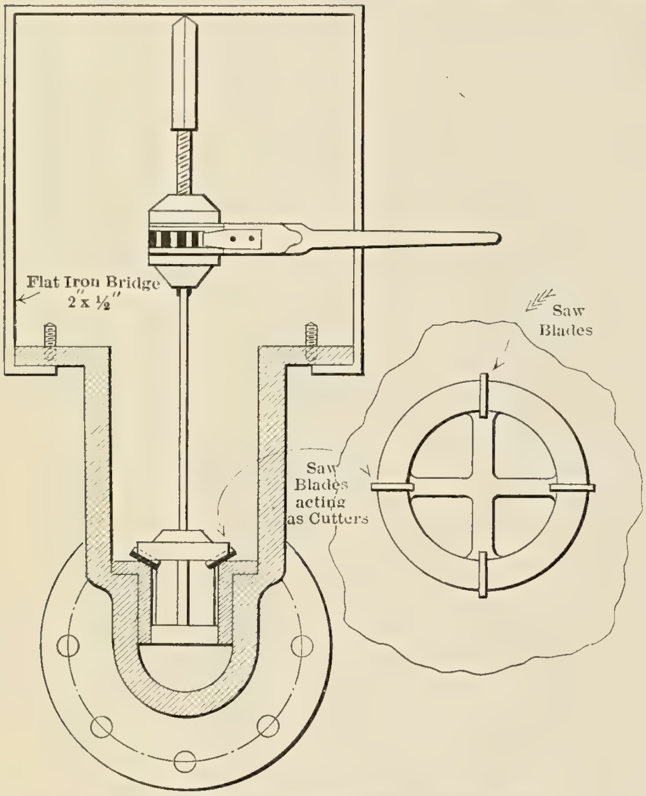
The following account of a breakdown at sea and novel method of repairing same may prove interesting reading and, perhaps, will be worthy of note by seagoing engineers, who very often have to make "something out of nothing," as one might say.

I was trading to the Far East from London. We received orders to go to Bangkok, Siam. When near our destination, one of the boiler main check valve spindles stripped, with the result that nearly all the feed water was going into that boiler. In order to prevent this we made a bridge, or bridle, out of a piece of flat iron about 2 inches by ⅜ inch and long enough to get a ratchet in below with a drill, to tighten down on the end of the spindle and so regulate the supply of water to the boiler. We had to anchor at a place fifty miles from Bangkok, as we were drawing too much water to make that port, and the cargo was shipped down to us in steam lighters.

On being informed that we would be three or four days loading, we decided to put in a new spindle, so the boiler was cut out and blown down below the check valve, and

afterwards released of the pressure altogether. The cover was then taken off and the new spindle fitted. The spigot, or stopper, on top of the valve, being broken through excessive hammering, was replaced with a new valve complete. On examining the seat, we found it so badly cut and full of holes that the next thing to do was to face the seat up, since even with a new valve and new spindle the valve would not be tight.

With no engineering shop within a radius of fifty miles, and no cutters or machine tools aboard to face the seat up, a good suggestion was made, which we acted upon and which proved to be a huge success. With the bridge, or bridle, we had made acting as a drill post, we fixed the ratchet underneath, and out of a flat drill we forged a screw driver and cut a slot in the top of the old valve to suit the driver. In the bevel or miter of this valve four



Emergency Tool for Grinding Valve Seats

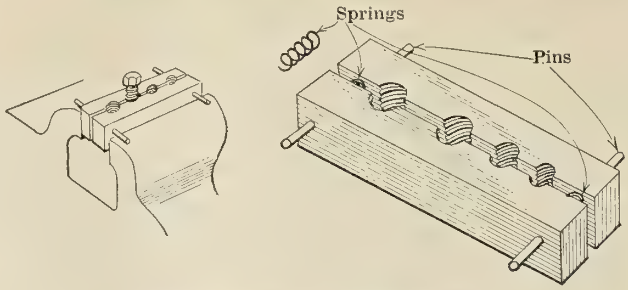
saw cuts were made almost the depth of a hacksaw blade. A hacksaw was then broken and four pieces were inserted in these slots, which were equidistant from each other, or 90 degrees on the circle. They protruded about 1/32 inch above the miter or bevel of the valve, and therefore the saw blades, being at the same angle as the miter of the valve, corresponded with the miter of the seat.

The valve was then placed in the seat, with the four pieces of saw blades acting as cutters. With the screw driver in the slot on top of the valve and inserted in the ratchet like a drill, and screwing up underneath the bridle by working the ratchet with a hand feed, we faced all the slots and holes out of the seat, and in the end the job was as good as if it had been done in the lathe.

Victoria, B. C. Edmund B. Dell.

Two Shop Kinks

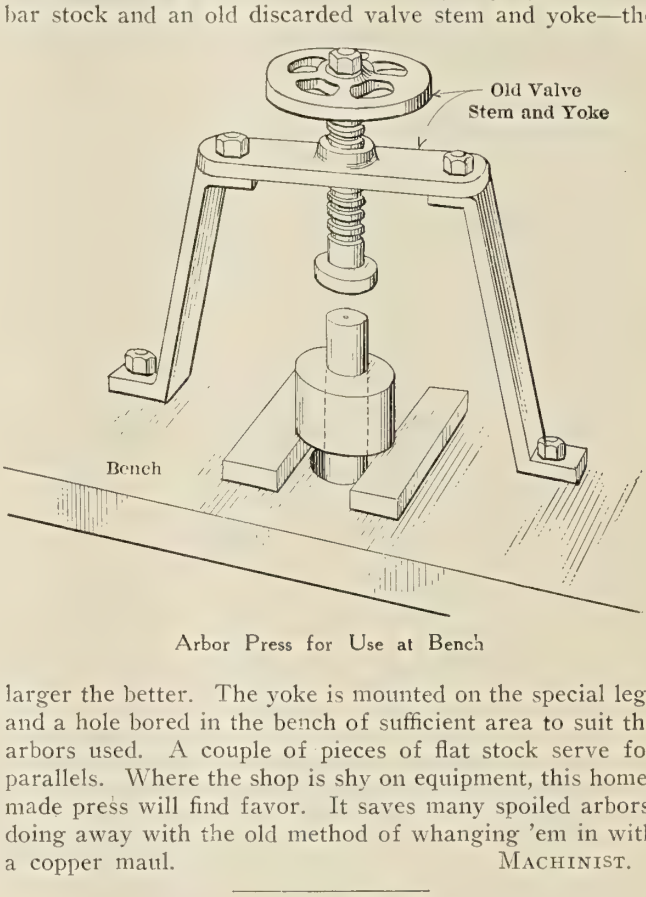
Here are a couple of kinks which the fellows working in the ship's machine shop will find worth adding to their collection. The jaws shown in illustration take studs, screws and bolts in the vise when threading, drilling or slotting. To make these, take a piece of stock, either brass or soft steel, 1½ by 1½ inches. Drill and tap a series of standard holes ⅜ to 1 inch; then drill two small



Special Clamp for Holding Screws

holes for the pins through each end on the sides. By splitting this piece through the center of the holes, two jaws are formed. Two ¼-inch guide pins serve to hold the jaws in place when in use.

The second sketch shows a small arbor press for use on the bench. It is made from a bit of ½ by 1½-inch flat bar stock and an old discarded valve stem and yoke—the



Arbor Press for Use at Bench

larger the better. The yoke is mounted on the special legs and a hole bored in the bench of sufficient area to suit the arbors used. A couple of pieces of flat stock serve for parallels. Where the shop is shy on equipment, this home-made press will find favor. It saves many spoiled arbors, doing away with the old method of whanging 'em in with a copper maul. Machinist.

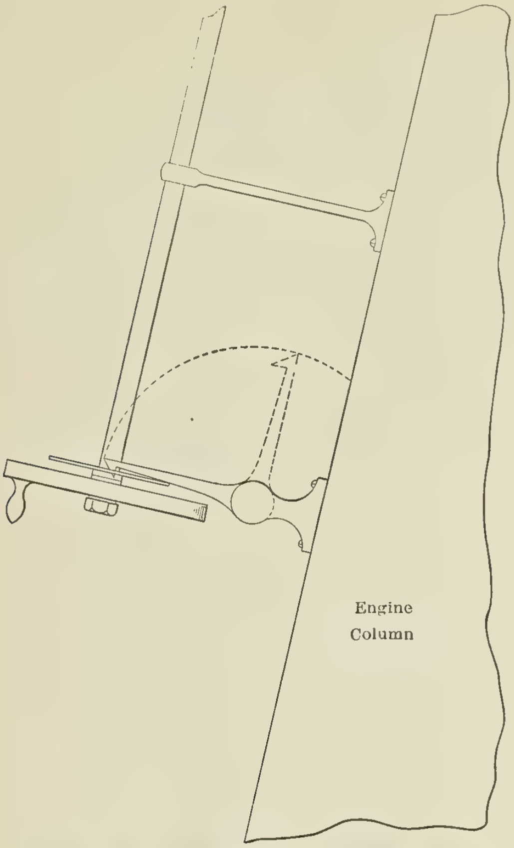
Device for Locking Engine Throttle Valve

Many marine engines have a long spindle attached to the stop valve for admitting steam to the engine, one end of which has a square socket which fits on a square on the valve spindle, with the other end terminating in a big handwheel near the starting platform, fixed at a convenient height for the engineer to open or shut, as desired. Very often, through vibration, the valve has a tendency to open up itself, and it is quite common to see this wheel tied with a piece of string after the engine is set at a certain speed and the necessary revolutions have been attained.

A very simple appliance was made by the writer to do

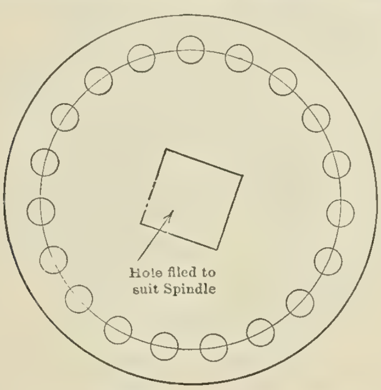
away with this tying-up process, and it is in operation now and giving every satisfaction.

Out of a piece of ⅛-inch brass I made a right-angle bracket, as shown, which I fastened to the column by two set-screws. Two cheeks were then made out of 1/16-inch brass and riveted on the bracket, which left ⅛ inch clear-



Drive for Locking Engine Throttle Valve

ance between the cheeks to allow the pawl to swivel round on the pin. The square on the spindle fitting into the handwheel was lengthened, and on this a circular brass plate was fitted. On this circular plate a pitch circle was drawn, and ¼-inch holes were drilled at ¾-inch pitch round the plate, as shown. An arm or pawl was made the required length to swivel round on the pin, being lightly riveted and sufficiently tight to remain in any position without dropping. When the arm was in position a sudden stop on the telegraph would not interfere with the rapid



Circular Plate for Locking Valve

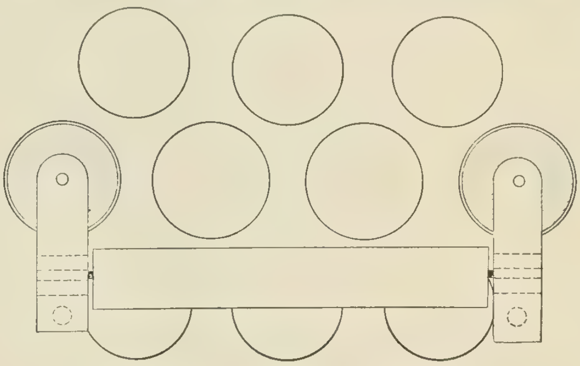
closing of the stop valve by the engineer; and in his haste to stop the engines as quickly as possible he would have no need to raise the pawl out of the hole, as the action of the wheel in closing the valve wedges the arm up clear of the hole.

When working engines into port the pawl can be raised to allow of the frequent opening and closing of the valve, as the appliance is intended only to keep the valve at a fixed opening to steam, once the necessary revolutions are attained. No particular dimensions can be given regarding the length of pawl, size of plate, etc., the reason being that no two ships are alike, and standardization in marine engines is only in the embryo. ENGINEER.

Saving Hose on Boiler Tube Cleaners

When cleaning boiler tubes with a water or air turbine cleaner it is necessary to insert and remove the hose supplying the air or water many times. Because of the rough nature of and sharp projections on some of the tube ends and sheets the hose soon wears through.

This wear and tear can be cut down considerably by using a roller device somewhat as shown in the sketch.



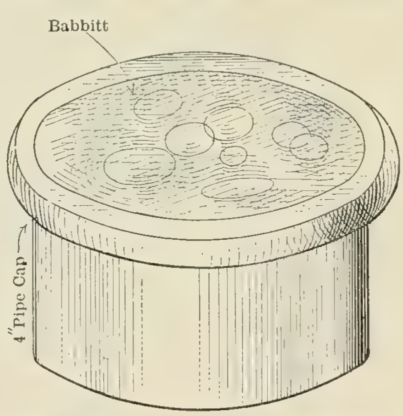
Roller Device for Saving Cleaner Hose

The roller can be made out of a piece of round wood rotating in two supporting brackets, which in turn are held against the boiler by two wooden pegs about 2 feet long, fitting into two of the boiler tubes. If the boiler construction precludes this design, the roller can be suspended from the ceiling by wires or from the floor on suitable standards.

Philadelphia, Pa. W. A. LAILER.

Gasket Punch Block

This is a quite simple kink, but worthy of space in any note book. A large size pipe cap is poured full of lead



Babbitt Filled Cap for Punch Block

and smooth, flush with the top, to give a soft cutting block on which to cut out gasket holes with the regular washer punch. The lead cannot spread or get all out of shape as it does when a piece of it is used alone on the bench.

C. H. WILLEY.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY H. A. EVERETT

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number of from examination for grade of chief, and by a dagger (†) if from examination for other grades.

How to Lay Out Shell Expansion Plan

Q. (990).—Will you kindly explain or show how the shell expansion drawing is laid out in the way of cants? I don't mean the laid-out plates as shown in the August issue, but merely a transverse expansion. I would also like to know how to get the true shape of the shell plates where they take transverse and longitudinal shape.

A. (990).—The shell expansion plan does not represent the correct shape of the various plates (except in the parallel middle body), due to the fact that no account can be taken of the longitudinal curvature. Its sole purpose is to indicate the position of the various plates, type of riveting, and the attachments of structure fastening to the shell plating.

One authority advises that the expansion of the shell in the way of the cant frames aft of the transom plate be obtained from the expansion of the actual plating at this point. This is not necessary, since no measurements are made by scaling the shell expansion. A convenient way of obtaining an approximation of the shell aft of the transom is to take a sheet of paper and place it on the plating model so that one edge coincides with the center line of counter. The position of the knuckle, rail, and cants can then be marked closely enough to transfer the same to the shell expansion plan.

In reply to your question as to the true shape or approximate development of shell plates having both transverse and fore and aft curvature, I would refer you to a very good article, entitled "Mold Loft Notes," by T. L. Cohee, in International Marine Engineering, 1917, p. 389.

Method of Installing Engine in Ship

Q. (989).—Can you give me a brief outline of the general practice of installing a main engine in a new ship? That is, getting the position of the bedplate, showing how the columns are mounted and the cylinders placed on them and how the lining up is done. I presume that everything is lined up from the tail shaft out to the engine and then the piston rods and guides, etc., are lined up by getting the center of each cylinder and gland and lining up with the crank on top and bottom centers, or as nearly as the wire will allow the crank to be turned. I do not expect you to go very deeply into this subject, but please give me just a brief outline of how this work should be done, so that I can follow your instructions.

A. (989).—It will be understood first of all that the engine has been previously lined up in the shop. If a planer large enough is available, the whole bedplate may be planed in one operation, viz., bearings, housings, and column seatings. If a suitable planer is not at hand the bedplate may be machined in sections, and the bearings bored out to give the proper alignment when tested by a taut steel wire. The bottom of the columns should be solidly bolted to the bedplate. Upon the tops of these the cylinders are clamped and adjusted until a piano wire stretched through the center of the stuffing box and center of the cylinder top intersects and is perpendicular to the wire through the center of the main bearings. After making sure that the center of the connecting rod will come half way between the bearings, the cylinders may be permanently bolted to the column tops. We may now proceed with the erection of the remainder of the engine.

Where there are crane facilities for handling the main engine, it is often installed without taking down any of the parts. With the vessel on the ways, the line of shafting from the center of the hole for the stern tube in the stern post to the boiler room bulkhead is found. If this length is short, a steel piano wire will be sufficient. If not, the more elaborate method of defining the center line of shafting by means of a ray of light and suitable shutters should be employed. All necessary holes in the stern post and bulkheads may now be bored, and the bearings for the line shafting fitted.

With the line and thrust shafting in place, all is ready for the installation of the main engine, which may now be lowered on its chocks or liners. By the use of a feeler gage between the engine coupling and the forward thrust shaft coupling, the main engine may be adjusted to give a constant clearance all around these couplings. This will insure that the engine shaft is in line.

Should the engine be installed in sections, the bedplate may be located so that the center of the main bearings will line up with a steel wire set to represent the center line of the shafting. The center line of the cylinders may now be tested with the main shafting in place (connecting rod, piston rod, piston, and cylinder cover removed) by stretching a wire through the center of the cylinder. With the crank as near the top center as the wire will allow, measure the distance from the wire to the crank web, turn the crank to the bottom center, and repeat this measurement. If these measurements are the same, the center line of the cylinder is perpendicular to the center line of the shafting.

Development of Longitudinals

Q. (986).—I am at present employed in the mold loft of a steel shipyard and am developing longitudinals. I would appreciate it very much if you would send me the most simple and practical method of the development of longitudinals in the Isherwood system of framing vessels.

A. (986).—Longitudinals are commonly run parallel to the decks on the side of ships and on the bottom parallel

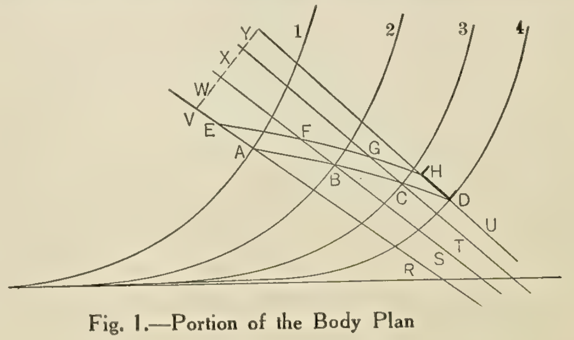


Fig. 1.—Portion of the Body Plan

to the keel. They are spaced two and one-half to three feet apart, and may run in one piece even to a length of 30 or 40 feet, being efficiently spliced at the joints and carefully bracketed to the bulkheads at either end. In oil tankers they stop, of course, at the bulkheads.

For the bottom longitudinals next the keel, buttock planes will give ready means of obtaining a template. The development of the longitudinals along the side is simple, since it is similar to that of the deck. Where the hull is of double curvature, this is not so easily done, and accuracy requires special care. The longitudinals are run as nearly normal as possible to the frame contour, and their position determines the best and simplest method of development.

The usual procedure is to consider that the longitudinal lies in a warped surface. Develop this surface and obtain the shape of the template for the longitudinal from that. In Fig. 1 we have a portion of the body plan in which *A, B, C, D* represents the heel of the longitudinal at stations 1, 2, 3 and 4; also *EA, FB*, etc., are the traces of the longitudinal. The first step consists in producing these traces. If the traces are nearly parallel, the development is not very difficult. Draw a line *VY* which will be a mean between the perpendiculars to the traces *EA* and *HD*. Draw *RU*, making *VR* equal to *YU*.

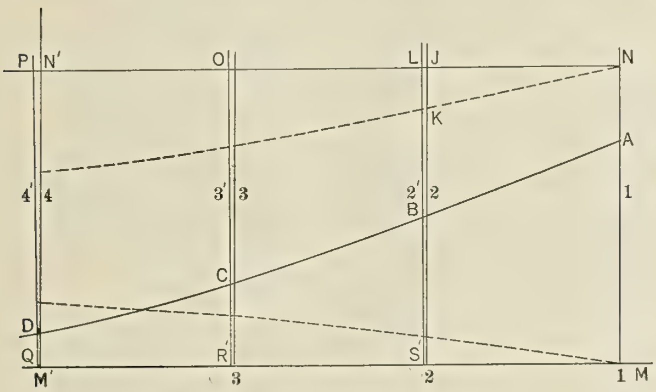


Fig. 2.—Diagram of Station Lines

In Fig. 2, lines 1, 2, 3, 4 represent the station lines. On station 1, lay off *MN* equal to *VR*, Fig. 1, and erect *MM'* and *NN'* perpendicular to *MN*. We must next allow for the fact that the station lines on the warped surface are farther apart than the actual station spacing, and are not likely to be parallel. On station line 2, lay off *JK* equal to *VW*, then *KN* will equal the distance from *N* to the station line 2, allowing for the curvature of the surface. Make *LN* equal to *KN*. Follow this procedure through, thus obtaining the points *L, O, P, Q, R, S*, Fig. 2. We may now draw the station lines 2', 3' and 4'. The figure *N L O P Q* .. *M*, Fig. 2, will closely approximate the development of the surface *V W X Y U* . . . *R*, Fig. 1.

Take *NA, LB, OC, PD*, Fig. 2, respectively equal to *VA, WB, XC, YD*, Fig. 1. If now line *A B C D* is drawn, we have the development of the longitudinal. A mold would be made to this curvature and given to the angle-smith. When the traces *EA, FB*, etc., of the longitudinal are not very nearly parallel the method of obtaining the position of the station lines is not so easy; triangulation may be then employed. Different loftsmen have approximate methods which will produce satisfactory results to anyone engaged in the work. The initial steps alone differ as a rule, and where caution is exercised one will not necessarily go far astray, provided, of course, some unusual features are not involved in the problem.

NEW BOOKS

United States Coast and Geodetic Survey issues new volume of "Coast Pilot."

There has just been issued by the U. S. Coast and Geodetic Survey a new volume entitled "The United States Coast Pilot, Atlantic Coast, Section B," covering the coast and interior waters from Cape Cod to Sandy Hook, including Nantucket Sound, Vineyard Sound, Buzzards Bay, Narragansett Bay, Long Island Sound and tributaries, and New York Harbor and tributaries.

This volume, which replaces a part of Coast Pilot Part III, and all of Coast Pilot Part IV, has been revised and brought up to date from new data collected in 1917. It contains descriptions of all navigable waters within its limits, with directions for navigating them; information concerning port facilities, where supplies can be had and where repairs can be made; tide and current information, and much other information usually contained in a coast pilot.

Programme of Annual Meeting of Society of Naval Architects and Marine Engineers

The twenty-sixth general meeting of the Society of Naval Architects and Marine Engineers will be held in Witherspoon Hall, Philadelphia, Pa., located at Walnut and Juniper streets, Thursday and Friday, November 14 and 15, and will begin at 9:30 A. M. each day.

The annual banquet will be in the Grand Ball Room of the Bellevue-Stratford at 7 P. M. Friday, November 15.

The Council will meet at 3 P. M. Wednesday, November 13, in the office of the secretary-treasurer, Daniel H. Cox, U. S. Shipping Board Building, 140 North Broad street, Philadelphia.

Thursday, November 14, 1918

1. "The Delamater Iron Works."
   By H. F. J. Porter.
2. "Revival of Wooden Shipbuilding as a War Emergency."
   By Carlos deZafra.
3. "Application of Buoyancy Boxes to Steamship *Lucia* for the United States Shipping Board."
   By W. T. Donnelly.
4. "Notes on Progress in Turbine Ship Propulsion."
   By Francis Hodgkinson.
5. "Notes on Launching."
   By William Gatewood.
6. "Side Launchings of Ships on the Great Lakes."
   By Frank E. Kirby and Edward Hopkins.
7. "Structural Steel Standardized Cargo Vessels."
   By Henry R. Sutphen.

Friday, November 15, 1918

8. "On Vibrations of Beams of Variable Cross Section."
   By N. W. Akimoff.
9. "Experiments Upon Simplified Forms of Ships."
   By Professor H. C. Sadler and T. Yamamato.
10. "Variation of Shaft Horsepower, Propeller Revolutions and Propulsive Coefficient With Longitudinal Position of the Parallel Middle Body in a Single-Screw Cargo Ship."
    By Commander Wm. McEntee, Naval Constructor, U. S. Navy.
11. "Recent Developments in Shipyard Plants."
    By Commander Sidney M. Henry, Naval Constructor, U. S. Navy.
12. "Present Status of the Concrete Ship."
    By R. J. Wig.
13. "The Application of Electric Welding to Ship Construction."
    By H. Jasper Cox.
14. "Hog Island—The Greatest Shipyard in the World."
    By W. H. Blood, Jr.

Shipbuilding and General Marine News

Contracts for New Ships—Shipyard Improvements—Engineering Projects—Improved Appliances—Personal Items

NEW SHIPYARDS AND EXTENSIONS OF EXISTING YARDS

Additions, Improvements and Orders for New Equipment

The Medomak Shipbuilding Company has been organized at Waldoboro, Me., with Capt. Willard F. Wade as president; Arthur E. Lord, of Lynn, vice-president; Josiah Grossman, of Lynn, treasurer, and John V. Poland, Quincy, Mass., general manager.

The St. Petersburg Maritime & Construction Company has been organized at St. Petersburg, Fla., with L. B. Brown, president; W. H. Franklin, vice-president, and F. Francke, secretary.

The Astilleros de Tarragona, S. A., has been organized at Tarragona, Spain. It is stated that there will be four berths in this yard.

The Dawn Boat & Shipbuilding Corporation has been incorporated by E. Hehre, J. W. Becherer and G. Auer, 912 Forest avenue, New York.

The Brude Line Boat Company has been incorporated by A. Johannessen and H. Gunderud, 3089 Broadway, New York.

The Marine Corporation has been incorporated at Los Angeles, Cal., by W. P. Winston, R. B. Aitchison and James R. Williams.

Louis B. Harrison Shipyard Company has been incorporated at Athens, N. Y., by J. F. McKinney, L. B. Harrison and M. H. Reiss.

The United States Navy Department, Washington, D. C., is planning to build a large dry dock and ship repair works at Stapleton, S. I., on property belonging to I. T. Williams & Sons. The Navy Department has also taken over the plant of the Merritt & Chapman Derrick & Wrecking Company, in the same district, to be used for the same purpose.

The Marine Works has been incorporated by H. Kaplan and H. Barrow, 59 East 118th street, New York.

The Gray Haven Shipbuilding Company has been organized at Detroit, Mich., and will build concrete barges for the New York State barge canal.

The Manistee Shipyard Company, Manistee, Mich., will soon begin work on barges for the New York ship canal.

The Victor Barge Corporation has been incorporated by M. C. Sullivan, J. C. Duke and B. B. Mead, 1999 Washington avenue, New York.

The Watercraft Construction Company has leased from the Degnon Realty & Terminal Improvement Company, 68 Hunters Point avenue, Long Island City, a tract of land on Flushing Bay, where they are planning to build a plant for the construction of wooden barges.

The Bruce Dry Dock Company, Pensacola, Fla., is planning to build a new dry dock.

The Fabricated Ship Corporation has been organized at Milwaukee, capitalized at $600,000. Already the Government has awarded contracts for thirteen steel ships, most of which will be 172 feet long and 32 feet beam.

A new shipbuilding company, to be known as the North Country Shipbuilding Corporation, has been incorporated, with a capital stock of $150,000. The yards will be at Ogdensburg, N. Y.

The New Bedford Dry Dock Company, Stonington, Conn., has been incorporated by Mark L. Gilbert, Mystic, Conn., and others.

The Ambursen Construction Company has commenced operations at its new shipyard at Little Ferry, near Hackensack, N. J., for the construction of a number of concrete boats for the Government. Headquarters of the company are located at 61 Broadway, New York.

The New York Shipbuilding Company, Camden, N. J., is rapidly completing its new shipyard along the Delaware River front. The cost of the new plant, which is being built in co-operation wtih the United States Shipping Board, is estimated at around $10,000,000.

The Mobile Shipbuilding Corporation, Mobile, Ala., to secure materials for the construction of steel vessels at its plant, has commenced the construction of a new steel fabricating works on Fifth avenue, Birmingham, Ala., under the name of the Birmingham Steel Corporation, with Henry Leon Brittain as president of both organizations.

The Milliken Bros. Manufacturing Company, Inc., following the occupancy of the former plant of Milliken Bros., Inc., Milliken, Staten Island, N. Y., by the Downey Shipbuilding Corporation, has been formed to take over certain assets of the former company and continue its name. C. T. Clack, for many years connected with the United States Steel Corporation, has been made president; J. E. Jennings, vice-president and secretary; Robert Grant, treasurer. Offices have been established in the Woolworth building, New York.

The consolidation of the Luckenbach Company, Inc., and the Luckenbach Steamship Company, Inc., was recently consummated at a special meeting of the shareholders. The two companies are now united under the name of the Luckenbach Steamship Company, Inc. The consolidation has only a formal significance and involves no change in the practical conduct of the company.

Navy Yard Contract Let

The Department of Labor authorizes the following:

A contract for siding and excavation at project No. 27 A. B. and C. Washington Navy Yard has been awarded to R. G. Colins, Munsey Building, Baltimore, Md.

PROGRAMMES FOR SHIPBUILDING IN FOREIGN NATIONS

Australia's Ship Plans Extensive

Details of Australia's shipbuilding programme show that two Isherwood standardized steel ships, each of 5,500 tons, are being constructed at the Williamstown Shipbuilding Yards, and six others are to be subsequently built there. Delay has been caused by the late arrival of shipbuilding material from America. Six similar standardized vessels are being built at Walsh Island, Newcastle; two at Cockatoo Island dockyards, Sydney; two at Devonport (Tasmania).

Two contracts for the construction by private firms in Australia of wooden ships, to be fitted with auxiliary engines, have been completed, one for six ships of 2,300 tons, and the other for six of 2,600 tons.

A definite proposition has now been submitted to the Commonwealth Government for the construction of six wooden vessels in Western Australia.

The ships under construction in the United States on account of the Commonwealth Government comprise 14 vessels, four first-class wooden cargo motor ships, of about 3,200 tons capacity deadweight, and ten first-class wooden cargo steamers (twin-screw). The four motor ships are being built at Olympia (Washington) by the Sloan Shipyards Corporation. The ten steamers are being built by the Patterson Macdonald Shipbuilding Company, at their yards at Seattle, Washington.

Italy Using All Available Ways

Italy is anticipating developments after the war. The "Cunard Line" of Italy, the Navigazione Generale, has increased its capital over 10 percent. This increase will be utilized in part for the extension of shipbuilding operations in the Cantieri Cerusa near Genoa and in the Cantieri Meridionale, Naples. In 1917 fourteen new Italian shipping companies were established and nine new shipyards. Nine old yards whose equipment has been considerably extended during the war are able to lay down at the same time 20 steamers of 8,000 gross tons and ten steamers of 5,000 tons each. Of the new shipyards only four are at present available. These could accommodate eight steamers, three of 8,000 tons and five of 5,000 tons each.

French Shipbuilding Programme

The new shipbuilding programme made public on October 9 by Fernand Bouislon, Under-Secretary of State of the Merchant Marine, includes vessels to be built representing a 1,500,000 tonnage.

Marine Internal Combustion Industries Organize for War Service

A War Service Committee has been appointed to work specifically in the interests of the marine internal combustion engine industry of this country before the War Industries Board and other branches of our Government.

The following representative manufacturers will serve on this committee:

Eugene A. Riotte (chairman), Standard Motor Construction Company, Jersey City, N. J.;

James Craig, James Craig Engine & Machine Works, Jersey City, N. J.

Charles A. Criqui, Sterling Engine Company, Buffalo, N. Y.

Ora J. Mulford, Gray Motor Company, Detroit, Mich.

Charles W. Pank, Fairbanks, Morse & Company, Chicago, Ill.

Richard R. Young, Union Gas Engine Company, San Francisco, Cal.

Mr. Seymour, McIntosh & Seymour Corporation, Auburn, N. Y., whose name was presented and favorably acted upon, was unable to be present at this meeting and has since notified the committee that, much to his regret, it will be impossible for him to serve owing to illness.

The committee is in touch with the Automotive Products Section of the War Industries Board and with the Statistical and Conservation committees with regard to certain conditions that must be met before the War Service Committee can properly prepare to take up the work in detail. The filing of a questionnaire by every engine builder of repute in this country is the first step. This questionnaire will be along the lines of those required of other industries by the War Industries Board, and in view of the nature of some of the information asked will be strictly confidential. When properly filled out questionnaires should be returned at once to the office of the War Service Committee, 29 West 39th street, New York City, from whence they will, when all have been collected, be turned over to the War Industries Board.

Seattle Shipbuilding Industry

Wages disbursed to the Seattle shipyards aggregate about $3,100,000 per month. The number of workers employed in shipyards and repair plants now total 27,400. The United States Shipping Board has awarded to one company contracts aggregated $100,000,000 of new ships, in addition to Government contracts previously issued. Contracts for fourteen steel freighters of 8,800 tons each have been awarded to another company; and five additional 8,800-ton steel freighters to a third company at a price estimated at $9,000,000. The following is a list of steel vessels contracted to be built in Seattle before the expiration of 1919; (1) 65 ships, 62 of which are 8,800 tons, and 3 of 7,500 tons, a total of 568,100 tons; (2) 24 ships, 22 of 8,800 tons, and 2 of 10,800 tons, a total of 213,600 tons; (3) 19 ships of 8,800 tons, totaling 167,200 tons; (4) 8 ships of 9,500 tons, totaling 76,000 tons; making a grand total of 1,024,900 tons.

Three Dry Docks for Philadelphia

The establishment of three dry docks at Philadelphia has been recommended to the American Shipping Board by the Commission on Port and Harbor Facilities. As a result of a meeting of the shipbuilding interests it was decided to recommend the type known as the "graving" dock, and that one of these, not less than 900 feet nor more than 1,000 feet, be constructed at Petty's Island; that one of 625 feet be built at Chester, and that the third be built either on the Philadelphia side of the Delaware River or on the New Jersey shore, or a moderate-sized dock on Petty's Island.

Over Thirty Million in New Ship Firms

Twenty-one new ship firms were organized during the month of September, with an authorized capital stock of $30,879,000. This brings the grand total for the entire war period up to $484,283,000. Of the September total $5,250,000 went into the actual building of ships, while $25,629,000 was the amount devoted to the operation of vessels. The development that has taken place in the shipbuilding industry in the United States is shown in the following table, which sets forth the authorized capital of new concerns:

Five months, 1914	$1,844,000
Year 1915	37,662,000
Year 1916	69,466,000
Year 1917	271,503,000
Nine months, 1918	106,758,000

To Combine Shipbuilding and Ship Operation

The Merchants Shipbuilding Company, of Bristol, Pa., headed by W. A. Harriman, has organized an operating complement to be known as the Independent Steamship Corporation, of which Mr. Harriman is to be the president. The new corporation will open offices at 69 Hanover street, New York. Several steamships have already been allotted to it by the Shipping Board. A combined shipbuilding and ship operating enterprise, one of the first of its kind, is thus formed. The precedent may be followed by other large shipbuilding concerns.

Hong Kong Shipping

The United States Consul-General at Hong Kong states that while the demands of the war have led to a constant and continued withdrawal of ships serving Hong Kong, particularly of British ships in the Australian, Philippine and coastal services, these withdrawals have been carefully made, and by taking over the control of practically all British ships on these runs the British Government has eliminated loss of space and waste in service, and managed so that the Colony's commerce suffered comparatively little from the restrictions.

In the transpacific routes few withdrawals for Government service elsewhere were made, but the governments concerned took over large cargo space and passenger accommodation on Pacific steamers for their own purposes. Early in the year the Japanese Government also took certain vessels of the Nippon Yusen Kaisha and the Osaka Shosen Kaisha, then in the Hong Kong Pacific coast service, thus withdrawing considerable steerage passenger accommodation from the market in Hong Kong.

Recent Shipbuilding Contracts Awarded

The Northwest Steel Company, Portland, Ore., has received a contract from the United States Shipping Board, Emergency Fleet Corporation, Washington, D. C., to build ten more 8,800-ton steel steamships.

The Toronto Shipbuilding Company, Toronto, Can., John E. Russell, general manager, has received a contract to build ten wooden steamships for the French Government.

The Albina Engine & Machine Works, Portland, Ore., has received a contract from the Emergency Fleet Corporation to build four more 8,800-ton steel steamships.

The Leatham D. Smith Shipbuilding Company, Sturgeon Bay, Wis., has received a contract from the United States Navy Department to build twelve wooden tugs, each 100 feet long.

The Elliott Bay Shipbuilding Company, Seattle, Wash., has received a contract from the Emergency Fleet Corporation to build five 3,500-ton wooden steamships.

The Northwest Engineering Works, Green Bay, Wis., has received a contract from the United States Navy Department to build thirty-four ocean-going tugboats.

New Contracts for Wooden Cargo Vessels

The Shipping Board announces that during the week of August 3 contracts for eighteen wooden cargo vessels and sixteen wooden barges were let.

Fourteen vessels of 3,500 tons each will be built as follows: Wright Shipyard, Tacoma, Wash., 2; the Midland Bridge Company, Houston, Tex., 8; John H. Fahey, Jacksonville, Fla., 4.

Four ships of 4,500 tons each will be built by Kiernan & Kern, Portland, Ore.

Ten barges will be built by the Midland Bridge Company, and 6 by John H. Fahey.

Boom in British Concrete Construction

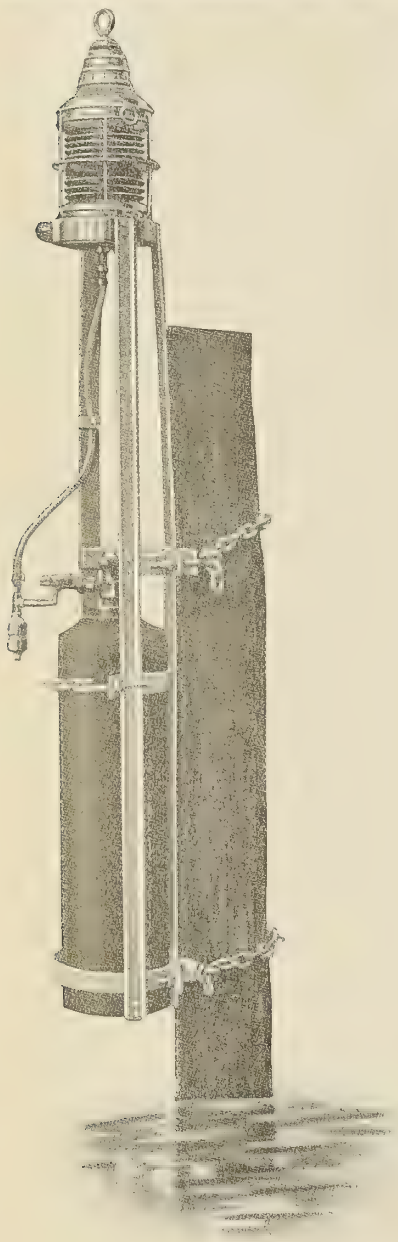
The yards in which reinforced-concrete ships and barges are being built are multiplying in the British Isles. Some 220 vessels are in course of construction. These represent a total of about 200,000 tons of shipping and a capital outlay estimated at nearly £4,000,000, apart from the cost of the land and the shipyard plants. On the designs adopted the saving of steel is about 70,000 tons.

The British Admiralty gives every encouragement to the private firms undertaking this new industry. Several vessels of 1,000 tons deadweight carrying capacity are already on the point of completion.

The vessels at present in course of construction for the Controller-General of Merchant Shipbuilding comprise barges of 1,000 tons deadweight carrying capacity and steam tugs of 750 h. p. In addition, six cargo steamships of 1,150 tons deadweight are being built for private ownership, and designs have been prepared for steamships of much larger size, which it is understood will be constructed after the pressing needs of the Government for smaller craft have been sufficiently met.

Long-Burning Acetylene Marine Beacon

The war necessity for rapid loading of vessels by night and day and for brilliant lighting at all times has led to the development of new types of marine lamps. The Milburn marine beacon, a fixed acetylene gas light which will burn continuously for a number of days without attention, represents one of the newest designs. This beacon, built by the Alexander Milburn Company, Baltimore, Md., consists of a storm-proof marine lamp with a Fresnel lens supplied with gas from a steel storage tank, which is



Acetylene Marine Beacon

held in a strong steel frame firmly attached to pole, pile or buoy. As designed, the burner gives a long, pencil-like flame within the lens, the rays of which are concentrated horizontally, so as to be visible up to a distance of five miles or more, according to requirements. These beacons are made in any size and candle power for any burning period. Arrangements are made for recharging the gas cylinders, used so that the cost of gas consumed is the only expense connected with the upkeep of the beacon.

The frame is made of rigid steel channel bars and steel bands securely riveted together and galvanized. Steel grips at the back of the frame, with heavy adjustable chain loops, secure a tight hold, regardless of variation in pole diameter.

Since these lamps are often installed in the open water, and all adjustment must be made from a rocking rowboat, the ease with which parts may be replaced and the lamp adjusted becomes an important factor. The flexible metal-armored tube connection between tank and lantern permits coupling and uncoupling of gas connections without difficulty, and provides for the opening of the lantern bottom without disturbing the gas connection

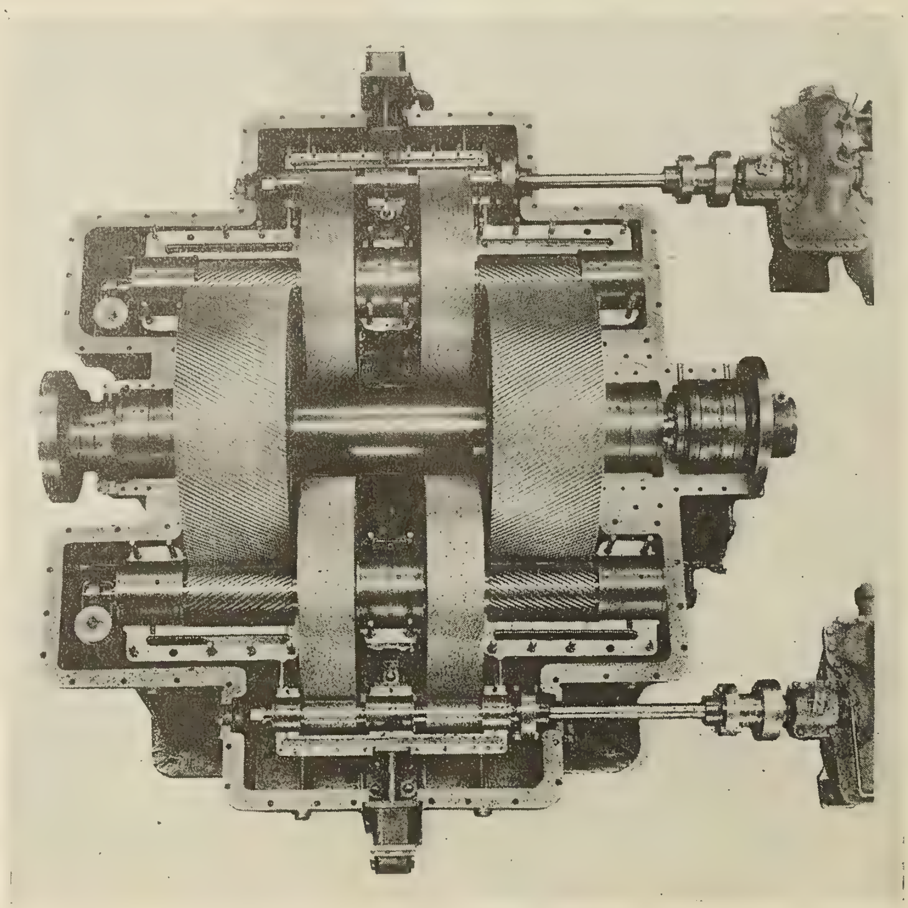
Floating Frame Reduction Gears for Ship Propulsion

The application of Westinghouse steam turbines with reduction gears of the floating frame type for ship propulsion is well carried out in the machinery of the tank and cargo steamers built and building at the yards of the Chester Shipbuilding Company, Chester, Pa., and other shipbuilding plants on both the Atlantic and Pacific seaboards.

Vessel Fitted with Westinghouse Floating Frame Reduction Gears

Geared turbine propelling machinery may be located in the stern of the vessel, as has been found expedient in the case of oil tankers, or its location may be amidships, which is usual for cargo ships.

As a typical example, in the case of a tanker, take the Malmanger (submarine), which was a vessel with the



Westinghouse Floating Frame Reduction Gears

principal dimensions listed as follows:

Length	401 feet
Beam	54 feet
Draft	25 feet 9 inches
Displacement	12,650 tons
Cargo capacity	9,000 tons
Speed	10.5 knots

The boilers and propelling machinery are located aft and comprise three single-ended Scotch boilers, a Westinghouse cross-compound turbine-unit, consisting of a high pressure turbine and a low pressure turbine, and two single-pinion first reduction gears, and one two-pinion second reduction gear. The arrangement is as follows:

Each turbine is coupled to one of the first reduction gears, which in turn are coupled to the second reduction gear, this latter gear being directly connected to the propeller shaft. By means of this arrangement of double reduction gears comparatively high speed turbines (3,600 r. p. m.) are utilized for driving a slow speed propeller (70 r. p. m.). The propeller thrust bearing is of the Kingsbury marine type and located at the forward end of the second reduction gear. The lubrication of the main turbine bearings, as well as the gear teeth and bearings, is effected by a continuous supply of oil through a gravity system. Two oil pumps driven off the gear shafts, a cooler, strainer and storage tank, also comprise part of the oil system.

The reduction gears are of the Westinghouse floating frame type. At the designed full power, the first or high-speed gears reduce speed from 3,600 to 450 r. p. m. and transmit 1,250 horsepower each. The second or low-speed gear reduces the speed from 450 to 70 r. p. m. Each pinion transmits 1,250 horsepower. The total speed reduction from the turbine speed of 3,600 r. p. m. to the propeller speed of 70 r. p. m. gives a ratio of 51.4 to 1. The gears are completely enclosed in an oil-tight cast iron gear housing, and are of double helical type, the teeth being inclined at an angle of 30 degrees. The teeth are of involute form and are cut with the utmost precision, to obtain reliable and quiet operation.

The pinions are of the three-bearing type and are carried in a floating frame, which automatically maintains the alignment of the pinion and gear under all conditions of load, thereby producing uniform distribution of the pressure over the entire length of tooth face. Each pinion is driven by a flexible shaft which extends through it and is secured to the end remote from endwise. The flexible shaft allows the pinion to adjust itself without restriction, to maintain its alignment with the gear wheel. The uniform distribution of pressure at all loads made possible by the use of the floating frame permits the use of the higher pressures and smaller pinions and gears than is the practice with reduction gears of the fixed bearing type.

The flexible frames are of rugged construction to avoid deflection, and are supported by feet under the middle bearing, this support being amply flexible to permit the required movement in a vertical plane. The ends of the floating frame are held in the correct vertical plane by horizontal struts. The frames are divided and bolted together horizontally, a longitudinal channel for supplying oil to the pinion bearings and teeth being formed in the joint.

The gear wheels are composed of a heavy forged steel shaft, a cast iron center and steel rims.

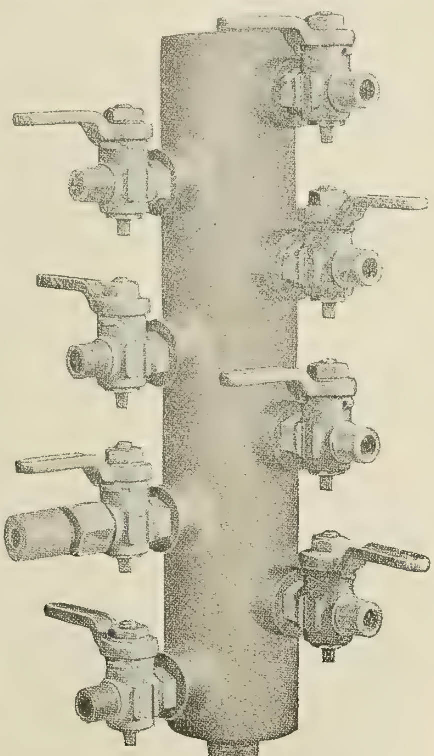
The gear and pinion bearings are composed of heavy cast iron bodies lined with genuine babbitt. The bearings are supplied with oil at a pressure of about 5 pounds per square inch, which is introduced at the sides. No oil piping is contained in the gear housing. A trough which is supplied with oil from the channel in the floating frame distributes the oil to the teeth from above, as shown. Oil is supplied to the teeth from below by sprays which are directed against the back of the pinion from the channel in the frame, the oil being carried around with the pinion and drawn into the meshing teeth.

The illustration shows a group of first and second reduction gears, as applied to geared turbine equipments for ships having their engine rooms located aft. With this arrangement the gears are placed forward of the turbines, and the intermediate shaft passes between the turbines, enabling the tail shaft to be drawn inboard for inspection without displacing any part of the turbines or reduction gears.

In the case of ships having engine room located amidships, the turbines are placed forward of the gears. The gearing for the two-speed reduction is contained in one housing.

The Victory Lubricated Air Cock

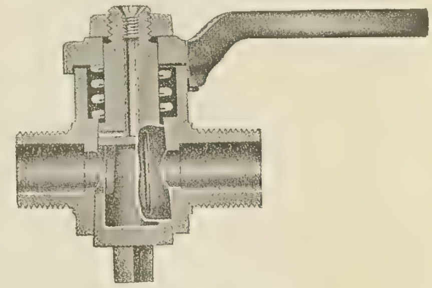
Developed by engineers whose years of experience have brought them into contact with the many difficulties and requirements connected with compressed air service, and particularly pneumatic service in shipyards, with full knowl-



Victory Cock in Use in Manifold

edge of the extreme hard working conditions and the terrific strain that would be placed on every part of the plant, the Victory lubricating air cock was designed as a part of the special equipment for the air service lines of the largest shipbuilding plant in the world.

This cock, which is placed on the market by the Victory Equipment Corporation, equipment engineers, 75 State street, Boston, Mass., has an oil pocket in the spindle, with outlets so located that each time it is operated enough lubricant is passed into the two oil



Section of Victory Cock

grooves on the inside of the body to prevent "freezing" or sticking. The stop plugs on body limit the handle to a quarter turn, preventing to a degree the scoring of body or spindle by any foreign matter that may lodge there. The large tension spring, which is a part of the Victory cock, will retain its properties, it is said, under severest use. The tension spring is so adjusted that the proper tension between the spindle and body is readily maintained.

The valve is adaptable to any pneumatic, oil, gas or low-pressure hydraulic service, and may be furnished with any type of connections desired. It is designed to be applied directly to the manifold pipe line or whatever fitting may be in use, thus obviating the necessity of additional nipples or connections.

An inspection of the valve will show that the body is of sturdy construction throughout; is compact, and the movable working parts are well protected by generous amounts of material around the sensitive portions. All parts are of extra heavy construction and are built to stand excessive strain and abuse.

As a means of shutting off and turning on the flow of air to a pneumatic tool, this valve is claimed by the manufacturers to be the most efficient on the market. It is the quickest in operation, it is said, and absolutely free from leakage troubles.

All cocks are tested before leaving the factory and are guaranteed to be airtight for hard shipyard service. They are made in all standard pipe sizes from ¼ inch to 3 inches.

The Theory of Graphite Lubrication

The theory of all lubrication is to keep two moving surfaces apart. In theory this is correct; in practice, however, any oil or grease will stand weight or stress up to a certain limit, but if unusual weight or stress is placed upon the machine the oil or grease will squeeze out from between the surfaces and allow the metals to touch.

Metals are never smooth. Under a microscope the most highly polished piece of metal resembles a nutmeg grater. There are little pin points sticking up between the pores in the metal, tool marks and other irregularities. When the oil or grease squeezes out these irregularities interlock. This is the cause

of friction. These little pin points also break off. This is termed wear. Tiny particles of metal get into the lubricant and, returning through the bearing parts, act as an abrasive.

It has been demonstrated, according to claims made by the Joseph Dixon Crucible Company, Jersey City, N. J., that the proper use of lubricating graphite entirely overcomes this wear, since it fills in the pores of the metal and places a veneer over the entire wearing surfaces. Contact then exists only between graphite-and-graphite and not metal-to-metal. Obviously, if metals do not rub together they cannot wear.

The Berg Concrete Surfacer

With the expansion of piers and the enlargement of dry docks upon concrete foundations, and the increased construction of concrete hulls, the development of the Berg rotary concrete surfacer is particularly opportune. This machine, especially constructed by the Elevator Supplies Company, Hoboken, New Jersey, is made for the rapid and economical removal of board marks, fins and other irregularities which remain after the forms are stripped. The surfacer may be fitted with a cutting or grinding attachment, according to the requirements of the work. These attachments are driven through a flexible shaft by an electric motor carried by the operator. The motor is of the universal type, suitable for both alternating or direct current.

Berg Concrete Planing Machine

The machine, which is ball-bearing throughout, is lubricated by one grease cup. This feeds the lubricant for the entire tool through the flexible shaft casing.

This ingenious tool is a splendid time and labor saver. After the stripping is removed from the forms and the broken corners and other defects have been filled in by a cement and sand mixture, the wires and nails are then cut off at least one-half inch below the surface. The material is now ready for smoothing with the Berg surfacer with cutting tool attachment. This consists essentially of a disk in which sixteen hardened steel cutter wheels are mounted. The wheels roll on the surface to be dressed, and are so designed that their teeth remove the material by a chipping action. The teeth, in effect, are tiny hammers which strike several million blows per minute, producing a surface which forms a good bond float or other finishes.

To secure lasting results, the prepared area is then thoroughly wetted down and a mixture of 1:2 cement and white screened sand, reduced by water to the consistency of thick paint, is then swabbed on in small patches. While it it still wet, the mixture is rubbed in with the stone grinding attachment. During the process it is advisable to keep the mixture sufficiently plastic by frequent moistening with water. The action of the stone, which rotates at high speed, has the effect of grinding up the plastic material and forcing the finely ground mixture into the pores. Further grinding removes the surplus and produces a well-bonded, smooth surface that is impossible of production by hand.

The speed of this compact machine is quite phenomenal. It is claimed that in removing projectiles and fins only, it will prepare at least 100 square feet per hour. The aggregate may be exposed similarly to a brush-hammer and an excellent surface obtained on green work, at the rate of 60 feet per hour. Special finishing on the inside corners of fillets, beams, and other parts is possible with the grinding attachment, which produces 35 to 50 feet of finished surface per hour.

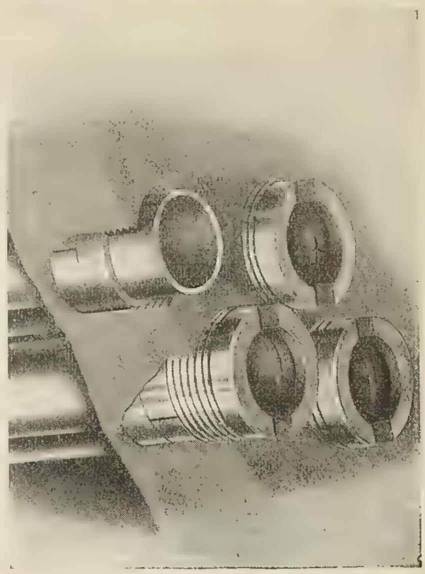
With labor and time at a premium, the need of a "speeding-up" machine is evident. The Berg surfacer supplies an integral link in the efficient chains which is rapidly being welded, it would appear.

Soft Flexible Metallic Packing for Condensers

It is now announced by The Crane Packing Company, 9 South Clinton Street, Chicago, after several years' actual use, that they have found "John Crane" Soft Flexible Metallic Packing to be an excellent packing for use in condensers.

The advantages of this packing in condensers are that it is permanent; fills crevices so completely that leakage is impossible; saves labor; and in the end is by far the most economical packing. Since the efficiency of steam turbines and condensing engines is dependent upon high vacuum, and since 12,000 tube condensers are not unusual these days, it is evident that the 24,000 tube packings in such condensers must be as good as human ingenuity can make them. They must prevent leaks dependably and permanently.

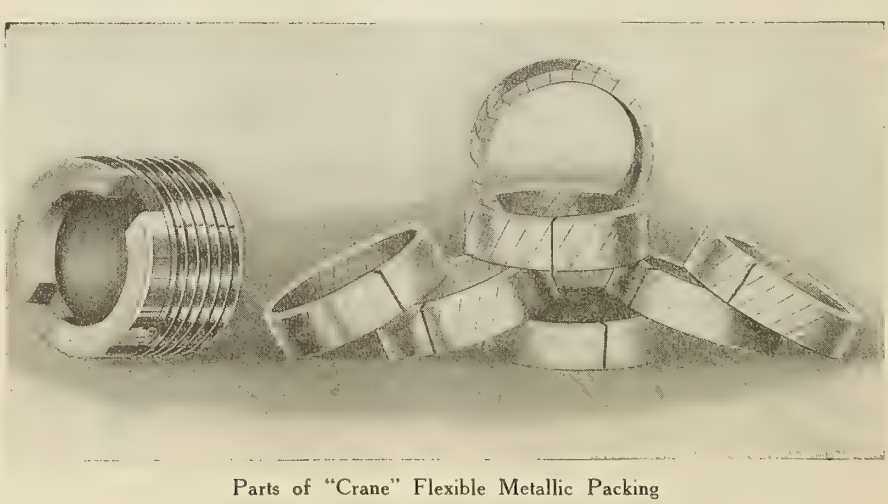
Cotton wicking, corset lacing, and fibre rings are not satisfactory, because they are not permanent. They eventually deteriorate under the action of steam, water, air, oil and heat. Sometimes these packings become hard or cement themselves into the tubes, causing the tubes to buckle. At best they are only temporary.



"Crane" Packing in Service

"John Crane" Soft Flexible Metallic Condenser Tube Packing is made of thin babbitt sheets, wrapped round and round spirally, lubricated between every layer and die-formed into rings, and as the result of this produces a ring of exact size and removes all guesswork as to uniformity. The simplicity of installation is apparent. This pliable metallic material under pressure of the gland completely seals the tube, yet allows freedom for the tube to slide. There is no expansion or contraction, nor yet excessive binding. A tube can be removed without disturbing the packing, and the same packing may be used for sealing a new tube. Also, the packing centralizes the tube. To insure against further leaks two or three rings, with joints staggered, are usually placed in each stuffing box.

This packing has another important advantage in that it is all-metallic and resists alkali, acids, salts, and such chemicals in solution. That pure circulating



Parts of "Crane" Flexible Metallic Packing

water is seldom found in central stations, water works plants, large industrial plants, is well known. In marine service the salt water circulating through condensers ruins any kind of fibre packing in a very short time, and when the sea water gets into the steam space of a condenser it is a serious thing. Chemicals and other foreign matter in sea water have been a source of great annoyance on board ship.

The entire elimination of these troubles when condensers and evaporators are equipped with "John Crane" Soft, Flexible Metallic Packing is the reason why marine engineers, as well as power plants engineers, should be interested in this new packing. A permanent leakless condenser tube packing is a great asset to any vessel at sea.

"John Crane" rings are just as flexible and pliable after years of installation as when they are new. They can be kept in stock indefinitely without deteriorating in the least.

The illustration shows how this packing is put in place in the stuffing box. Examination of this illustration will reveal that much time is saved in packing the tubes because of the fact that it is merely necessary to put in the readymade ring and screw in the gland, as indicated. Fitting, trying, removing portions, cutting off and the like, all are eliminated.

The packing has already been given a thorough tryout on land and sea. Users state that after two years of uninterrupted service in large condensers maintaining the highest vacuums not so much as a sign of a leak has developed. It is prophesied by the engineers in charge that this packing will last as long as the condensers.

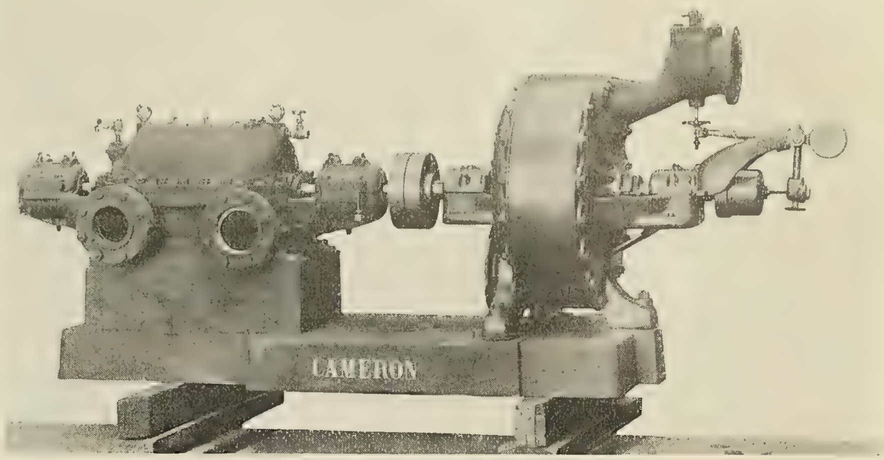
In ordering this packing it is obvious that the more information the manufacturer is given, the better. The outside diameter of the condenser tube should be given, and the inside diameter and depth of the stuffing box, the make of the condenser, the vacuum carried, the number of condenser tubes to each unit, and whether or not the stuffing box has a smooth bore. A rough sketch showing the stuffing box will assist both the user and the manufacturers.

This packing, it might be stated, is equally valuable on evaporators and heaters, and is now being used for packing practically everything in power plants and on ships, from valve stems to the largest plungers, and on service ranging from plain, pure water to concentrated acids.

Improved Centrifugal Pump

The development of the steam turbine and of the high efficiency multi-stage centrifugal pump have gone hand in hand. Up to the present, it has not been entirely practicable to reconcile the speeds of the two machines so that each would work at its best efficiency. It has always been necessary, heretofore, either to reduce the speed of the turbine and sacrifice much of its efficiency, or else speed up the pump with similar results. To overcome this difficulty a new type of multistage centrifugal pump has been designed by the Cameron Pump Works, 11 Broadway, New York.

The illustration shows this pump entirely assembled. The high speed feature is a virtue of the special impeller design. With the ordinary impeller the diameter cannot be reduced sufficiently to get high speed without sacrificing vane length, and consequently efficiency, since a certain vane length is very necessary in order that the impeller perform its function without excessive loss. Small external diameter and adequate vane length are obtained in this pump by bringing the vanes well down into the impeller hub. At the same time they are turned so that the incoming water is guided smoothly, and with little loss, into the outer portion of the vane. Here the velocity is generated that is finally converted into useful pressure by means of the external diffusion vane.



Three-Stage Type "BT" Boiler Feed Pump

Certain details in construction may be noted. The casing is divided along the horizontal outer line. Suction and discharge connections are in the lower half. The upper half is removable, giving access to the revolving element Suitable openings are supplied for draining the pump and displacing the air when starting. Inlet and outlet nozzles can be arranged on the same or on opposite sides —an advantage where pumps are installed in limited space. The shaft is made of high-grade forged steel accurately machined and ground. Contact with the fluid being pumped, is eliminated by the use of bronze sleeves, which prevent the stuffing box packing from scoring the surface of the shaft.

Each impeller, cast in one piece, is of the enclosed type. A pair of rings—one stationary, attached to the casing, the other revolving, attached to the impeller —surrounds each impeller hub. By the use of double rings the initial tightness of the joint between the low and high pressure sides of each stage is restored without fitting. The diffusion ring surrounds the impeller at its periphery, although not in contact with it. This ring contains a series of openings, which receive the water from the impellers at high velocity, reduce this velocity into pressure and enable it to advance to the entrance of the next impeller. If the high velocity of ejection were maintained a greater loss of energy would result.

This pump is equipped with a simple internal hydraulic balancing device to take care of thrust. This device consists of a revolving disk attached to the shaft at the inboard or high pressure end. Opposite this disk is a stationary drum of the same diameter. Water at high pressure connects with the space between the disk and the drum, causing the disk to react against the opposing thrust, neutralizing it and holding the rotor in proper relation to the casing. The slight leakage involved in this process is piped back to the suction. One ringoiled bearing, self-aligning, is located on each side of the casing of the pump. The bearing bodies are horizontally split, with removable caps. The bushings, also split, are lined with high grade bearing metal. Bushings and bearing bodies have a spherical fit, automatically maintaining the alignment of the shaft. The bearings are supported by strongly ribbed brackets, cast integral with the lower casing, thus counteracting any possible tendency toward vibration. These brackets are located sufficiently distant from the stuffing boxes to permit of adjustment of the glands. Felt washers are provided to prevent oil escaping from the bearings. The deep stuffing boxes are provided with water seals, consisting of a lantern gland in each box. By a concealed passage, so arranged that it can be readily cleaned, this gland connects with the water from the discharged side of the pump. The gland is fitted with swing bolts to give quick and easy access to the stuffing box.

When the pump is direct-connected, it is supplied with a shaft coupling of the flexible type to compensate for slight variation in alignment. As may be noted from the illustration, the bedplate under the pump is of one-piece box construction, heavy enough to give a rigid support, and with cross ribs to prevent distortion. The manufacturers believe that this pump occupies less space than the ordinary boiler feed pump of this general type, and that it will give a much higher degree of efficiency.

Seized Shipyard Lays Keel

A German-owned shipyard in the United States has laid down its first keel for the new American merchant marine. The event took place at St. Andrews Bay, Millville, Fla. The company, known as the American Lumber Company, has been taken over by Alien Property Custodian A. Mitchell Palmer, and is now under American management.

Albert E. Eledredge has been appointed treasurer of the George Lawley & Son Corporation, Neponset, Mass.

Fusible Plugs Approved

During the month of July, 1918, the following list of fusible plugs was approved:

American Injector Company, Detroit, Mich.; heat 45.

Crane Company, Bridgeport, Conn.; heats 116 and 117.

Detroit Lubricator Company, Detroit, Mich.; heats 94 and 95.

W. T. Garratt & Company, San Francisco, Cal.; heats 94, 95 and 96.

Glasgow Iron Works & Supply Company, New York, N. Y.; heat 80.

Marine Manufacturing & Supply Company, Pittsburgh, Pa.; heat 16.

Point Pleasant Machine Works, Point Pleasant, W. Va.; heat 55.

Richards Iron Works, Manitowoc, Wis.; heat 10.

Southern Pacific Company, New York, N. Y.; heat 58.

Vulcan Iron Works, Cairo, Ill.; heat 15.

PERSONAL

Rear Admiral Wilson, who is now in command of the United States naval forces operating in French waters, has been designated to succeed Vice-Admiral De Witt Coffman in command of Battleship Force 2, Atlantic Fleet.

James A. Farrell, president of the United States Steel Corporation, has been offered the position of Director of Operations of the Shipping Board. Edward F. Carey, the present Director of Operations, was recently made chairman of the Board's Port Improvement Committee in charge of reorganizing dock and harbor facilities throughout the country.

The introduction of the "Weiss type" of oil engine by the Weiss Engine Company again brings the career of its designer, Carl W. Weiss, member of the American Society of Mechanical Engineering, the French Legion of Honor and many technical associations to the front. In 1876, Mr. Weiss began experimental work in America with the Benton Manufacturing Company, New York. Press work at the Nassau & Bendit plant

Carl W. Weiss

engaged his attention in 1878. During the eighties his time was occupied in perfecting a mechanical register and adding machine for the Check and Adding Machine Company of New York, the patents of which were finally sold to the National Cash Register Company in 1889. During this period, also, he was engaged in designing caloric engines of both atmospheric and high pressure types and in building his first internal-combustion turbine type engine. In 1891 the Weiss four-cycle type of engine was introduced, followed, in 1894, by the two-cycle, known as the Mietz & Weiss oil engine—a practical surface-ignition medium compression unit. Since that time there have been manufactured and sold about 300,000 horsepower of these engines, designed and built under Mr. Weiss's supervision at the Mietz & Weiss plant. After three years of special laboratory work Mr. Weiss is again returning to the production field to supervise the building of the engine which bears his name.

Guy E. Tripp, formerly colonel, United States Army and Head of Production Division, has been made brigadier-general, United States Army, and has been placed in offices having charge of the production of ordnance material in their respective sections of the country. Previous to his connection with the Ordnance Department, General Trip was chairman of the board of directors of the Westinghouse Electric & Manufacturing Company, with headquarters in New York.

B. H. Tripp, special representative of the Chicago Pneumatic Tool Company on the Pacific Coast, has been appointed district manager of sales for the Pacific Coast territory, with headquarters at 627 Howard street, San Francisco, Cal. The Los Angeles branch of the company at 521 Title Insurance building will also come under Mr. Tripp's jurisdiction.

John Wilson, Seattle, Wash., has purchased the plant and land of the National Steel Construction Company, Seattle, Wash., where he will build steel tugs and ships up to 300 feet in length.

William Averill Harriman, chairman of the board of directors of the Merchants' Shipbuilding Corporation, 6 Hanover street, New York, is president of the newly organized Independent Steamship Corporation.

C. D. Morton has resigned his position as sales engineer for the Page Steel & Wire Company, to become a captain in the General Engineer Depot, United States Army, at Washington.

Charles E. Goodnow, formerly assistant sales manager of the electrical and special wire department of the American Steel & Wire Company, and more recently identified with building construction work in Washington and Brooklyn for the army and navy, is now with the Page Steel & Wire Company, 30 Church street, New York.

Sir Arthur Harris, since 1916 director of overseas transport for the Canadian Government, has been appointed director general of shipping for Canada by Sir Joseph MacLay, the British Shipping Controller.

George H. Waters, formerly president of George H. Waters Company, Mariners' Harbor, N. Y., has been appointed to the position of president of the Raritan Dry Dock Company, Perth Amboy, N. J.

John D. Garver, lieutenant in the navy, has been made instructor in the United States Naval Steam Engineering School, Hoboken, N. J.

Sherman L. Whipple, of Boston, who has accepted the position of general counsel of the Shipping Board Emergency Fleet Corporation, has established offices in Washington.

Major General George W. Goethals, who has been recently identified with ship engineering and shipping activities, has been made a member of the War Industries Board. He is assistant chief of the general staff and director of the Division of Purchase, Storage and Traffic.

OBITUARY

Theodore Benedict Johnson, president of the Johnson Lighterage & Towing Company and widely known in shipping circles, died on September 30, at the Ritz Carlton Hotel, from pneumonia, which developed from an attack of Spanish influenza.

The Shipping Control Committee recently appointed Mr. Johnson superintendent of lighters and barges at New York. He had been aiding the Government in dealing with the shipping situation here ever since the United States entered the war. In May, 1917, he turned his yacht *Seneca* over to the Government for the period of the war. Shortly before his death he had made arrangements for the inauguration of a service between New York and Lisbon.

On October 12, John P. Hopkins, chairman of the board of directors of the Pneumatic Tool Company, Chicago, Ill., and the largest stockholder in that company, died in Chicago of heart failure superinduced by an attack of influenza. In 1880, Mr. Hopkins began his business career as machinist with the Pullman Palace Cor Company, later he became partner in the firm of Secord & Hopkins, Pullman, Ill. In 1905 he became interested in the Pneumatic Tool Company. A national figure in politics, he served out the unexpired term of Carter H. Harrison, Sr., as Mayor of Chicago in 1893-1894, was several times chairman of the Democratic National Committee, and was secretary of the Illinois Council of Defense.

Hugh Vernon Ramsay, general superintendent of Pusey & Son's yards, in Wilmington, Del., and Gloucester, N. J., died at his home, in Gloucester on October 10, of pneumonia, following influenza. Mr. Ramsay was born in Summerside, Prince Edward Island, 43 years ago, and was the son of Hugh Ramsay.

Francis Norman, one of the widest known men in marine circles around New York, died September 27, 1918. He was a member of the Maritime Exchange of the port of New York, and for many years was superintendent of the Kerr Line of steamships. Captain Norman made his home on Stratford Road, Brooklyn.

Captain George P. McKay, Cleveland, Ohio, treasurer of the Lake Carriers Association, and one of the best known steamship men on the Great Lakes, died on August 5, aged eighty.

Henry G. Lytle, for thirty years cashier of Robins Dry Dock & Repair Company, Brooklyn, N. Y., died recently as a result of injuries in an automobile accident.

Captain David V. Woolsey, an old steamboat captain on the Hudson, died recently at Haverstraw, N. Y., aged eighty-two.

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Passing of the World's Cataclysm

THE church bells tolled out the message at 4 o'clock. The armistice had been signed. A people had been freed. Once more the world could right about and face the future, where for a period of four years and three months and seventeen days it had looked backward into the past—looked backward to the depth of a thousand years!

We are again born. We have witnessed a new dawn of democracy, a new peace on earth, a new good will toward men. It means much. It means universal freedom and the right of people to pursue happiness, to the end that future generations may likewise freely pursue happiness. It means that. But most of all it means, and meant—this early sounding of the bells that morning—that God still sits on his throne, and that Christ again walks upon the earth. The War is over. Thank God for it!

The Hog Island Shipyard

LARGE organizations of successful record are growths. They have attained to bigness through a long, slow, upward building, and in doing so have but followed natural laws. There is such a thing as forced growth, however—hot-house plants, for instance. But these pay for their quick expansion in some way. Hot-house plants whose size has been forced are delicate. Likewise, any organization that has sprung up to giant proportions over night must, from the very law of things, be delicate somewhere.

Criticism has long been directed at Hog Island. Hog Island has failed to deliver ships according to initial promise. The critics say that. But the critics have overlooked something. It is the time-worn and truthful axiom that large bodies move slowly. Hog Island, because of her unnatural growth—a growth forced to complete fullness almost between suns—has yet to expand spiritually in keeping with her giant physique. Hog Island will yet prove herself. With all her departments co-ordinated, and with her gigantic personnel working in spiritual harmony with the needs of the "shell"—the physical properties of the plant—it is our prediction that the yard will turn out ships for the merchant marine in numbers befitting both her size and productive capacity.

To Revive Normal Trade Routes

IT was learned recently that the Shipping Board, as far as consistent with Government needs, is diverting ships to normal trade routes, and that within a few months officials hope to have American ships carrying needed commodities of peace to South and Central America, Asia and Africa, as well as to Europe.

Some ships requisitioned by the Shipping Board during the war are being turned back to private owners, and the Board plans to return such vessels as rapidly as possible. In all, about 2,500,000 tons of shipping was requisitioned.

In turning the vessels back, the Board, it was said, will not relinquish any of its rights to any vessel. The private companies will carry on the detail work of maintaining, manning and operating the ships, taking their cargoes at the direction of the Shipping Board and paying the wages fixed by the Board. Some members of the Board believe that at least two years must elapse before control of any of the requisitioned ships can be given up.

New York Port Improvements

OF the many improvements which must be made in the near future if the port of New York is to maintain all the advantages of its present supremacy, at least two stand forth as great crying needs, according to Murray Hulbert, Director of the Port and Commissioner of Docks. The first is the dredging of Ambrose Channel, and the second is the removal of the Red Hook Shoals menace, opposite South Brooklyn, by converting it into an island, with piers and warehouses. The commissioner stated that a grave injury is suffered by the port of New York as long as the Government fails to carry out the channel-widening programme. He declared that Philadelphia and other cities were taking advantage of setbacks here due to errors in the past and were doing their utmost to induce steamship companies to desert New York.

The agitation for the extension of a channel 2,000 feet wide right up to the mouth of the North River is important at this time principally because gigantic port and terminal improvements are under consideration here to meet peace-time conditions and a greatly expanded American maritime activity. With these better docking facilities carried out, however, New York city's transatlantic commerce could not be handled under the present hazardous conditions, where mammoth ships creep up the bay through a water lane not much wider than a creek. Commissioner Hulbert stated it as his belief that several of the largest ships afloat should have enough space at any point in Ambrose Channel to move toward the Battery two or three abreast, and in this we heartily concur.

Will Keep Up Shipbuilding

CHAIRMAN HURLEY, of the United States Shipping Board, repeats that every efficient shipyard in the United States will continue to have all the work it can do for many years, in spite of the ending of the war. The present programme calls for fifteen million tons of merchant ships. So far we have only completed about fifteen percent of this programme. Yet while the programme as a whole will be revised and designs for ships will be changed with particular reference to economical cost of operation, the continued need for building American-owned tonnage is obvious. Not only must we continue to supply our armies overseas and prepare to bring them home at the earliest moment compatible with safety, but Europe must be fed and supplied with the necessary

materials to permit the reconstruction of devastated areas. in order that both our friends and our enemies may become self-supporting and the burden of feeding the world be taken from our shoulders. There will be no abatement of shipping.

Want New York Free Port

SHIPPING problems in connection with after-war development in various fields of industrial activity were discussed at length at a recent meeting of the New York Board of Trade and Transportation, and committees submitted reports on various aspects of the transportation situation as it concerns the port of New York.

One report expressed approval of the recommendations of the United States Tariff Commission, extending the bonded warehouse system to include storage as at present, repacking and manipulating, manufacturing for export or domestic consumption, and in addition that the general bonded warehouses be permitted, where all or a portion of the floor space may be used for repacking, manipulation and manufacturing, for export or withdrawal, for domestic purposes upon payment of duty on the original imported merchandise. Also it was pointed out that free ports have been created and maintained in other countries and have resulted in vast benefits to the commerce and manufacture of those countries. The meeting closed with the recommendation of the After-War Organization Committee to the effect that the president of the Board appoint a committee to make a special study of conditions, and to report from time to time on advisable steps for the reorganization of matters pertaining to commerce and industry, both here and abroad.

Uniform Wage Rate for World Sailors

CHAIRMAN HURLEY, of the Shipping Board, now in Europe, plans to seek an international agreement between the governments, shipping interests and labor organizations of the principal maritime powers for standardization of seamen's wages and working conditions. Mr. Hurley expects to propose that the American laws and the agreements between the Government and the seamen's unions be accepted as the standards, and it is understood that the American Federation of Labor and the British Seamen's Union are prepared to support the proposal.

Such an agreement as that contemplated by Mr. Hurley, it seems obvious, would eliminate the chief difficulty that has confronted American shipping interests in past years in their attempts to operate in competition with other nations. The standards of American seamen are said to be the highest in the world; and now that this country is putting a great fleet of merchant ships on the seas, officials believe that unless some international agreement is reached a great proportion of trained seamen will be attracted to the American merchant marine.

Will Close Some Wooden Shipyards

IMPATIENT of the lack of progress and the inefficiency of a considerable number of shipyards engaged upon wooden ship construction, Shipping Board officials have agreed that upon the expiration of existing contracts no further contracts will be awarded for Government ship construction to those yards that demonstrated their inability to fill the Board's building requirements. This decision will be formally ratified at a conference presently between Chairman Hurley, of the Shipping Board; Charles M. Schwab, Director of Shipbuilding Operations; Vice-President Piez, of the Emergency Fleet Corporation, and other Shipping Board and Emergency Fleet Corporation officials.

It has been roughly estimated that between fifteen and twenty yards out of a total of more than 105 yards engaged in wooden ship construction will be affected by the Shipping Board's action. The inefficient yards are confined to no particular section, but are in all parts of the country.

In arriving at their decision virtually to close down inefficient wooden ship plants, Shipping Board officials hold that they already have spent enough time, money and attention upon the wooden shipyards to start them upon actual construction work; a large part of this time should have been spent in speeding up the construction of steel shipping. Notwithstanding, a number of yards, through inefficiency, sheer ignorance of the industry of building ships, and other causes, have made practically no progress, when comparison is made with the remarkable accomplishment of other yards throughout the country in the rapid construction of a merchant marine under the spur of war necessity.

This action of the Board is in line with the policy of that branch of the Government to take every possible step towards the ultimate object of maximum ship production.

Strainagraph Records Ship's Strains

A NEW device to record the "give" of a ship, very similar to the seismograph that makes an accurate record of an earthquake shock, has been developed by F. R. McMillan, research engineer of the Concrete Ship Section, and H. S. Loeffler, assistant research engineer of the section.

When equipped with this device, every strain that a ship experiences in a storm, or, for that matter, in any weather, is graphically recorded on a strip of paper which passes under the recording needle in the instrument. The apparatus was tried out on the concrete steamer *Faith* on her first voyage.

The strainagraph is built somewhat on the principle of the seismograph and the numerous devices used by doctors to record pulsebeats and other movements peculiar to the human machinery. It may be destined to play an important part in future ship designing, since it gives a simple medium for comparison of the relative strength of different types of ships. These instruments, placed in different parts of a ship, by showing weakness in these locations, give the expert a workable chart upon which to build an analysis of a ship's seaworthiness.

Fig. 1.—Typical Inland River City with Steep Bank, Showing Terminal Possibilities

Handling Freight on Inland Waterways

Advantages of Effective Inland Terminals—Operating Costs Small—Importance of Mechanical Methods

BY H. MCL. HARDING*

MANY of the smaller communities along the inland rivers could now take advantage of the saving effected by river transportation, as the larger cities are doing, were they provided with correctly designed and equipped terminals. The expense of installing permanent terminals, such as would give capacity and speed of transference, economy of operation and facility for handling all kinds of material and package freight, has in the past required too great an investment for many of the smaller towns. By utilizing present engineering plans and designs, however, and adapting standard hoisting and conveying machinery with movable cross-tracks, the cost of investment in a terminal which would fulfill all conditions for river traffic for the smaller towns has now been so reduced as to come within the financial possibilities of very small communities. This has been made possible not by new appliances but by the adaptation of standard machinery in accordance with correct terminal principles.

As is well known, the terminal operating expenses upon unimproved river banks are so great as to nullify the advantage of the lower rates of water over rail transportation. This is especially true of those towns and villages which have high river banks. The transference of freight between the river and the top of the bank has accordingly been one of the serious problems to be overcome.

* Former president, Society of Terminal Engineers, New York, N. Y.

For the successful operation of terminals at the smaller towns and villages—terminals which will give the requisite capacity and economical operation—the following requirements are essential:

A village can only make a small initial investment, as the quantity of freight may not be great and often the resources available are not large. The operating costs must therefore be small. Saving of manual labor on the barge and in the terminal operations on shore is essential. In some way the drag up the steep bank must be eliminated, and the rehandling movements—as from the top of the slope into the shed—reduced to a minimum. Furthermore, barges must not be detained any longer at the terminal than the shortest time necessary to discharge and load the freight, to say nothing of the fact that there should be a possibility of increasing the capacity of the terminal without effecting any change in that portion already installed.

A shed for the protection of freight against inclement weather and thefts, the same as a railway freight station,

Fig. 2.—Showing the Elevation of the Upper Level of the Bank from Opposite Shore

should be built. Since much of the freight is through freight, co-ordination is required between water and rail, and it must be possible to lift and swing the freight directly from the car to barge or from barge to car. Likewise, the cars should be already in place on top of the bank to avoid the usual waiting for the locomotive or the drilling engine to move or place the cars, as is the case when car inclines are used in the equipment of a terminal. Another thing, the placement tracks should be controlled by the terminal authorities, although at the beginning of the terminal operations those tracks existing and belonging to the railroads could be utilized. The railway companies, according to federal law, will make railway connections with the river terminals.

If provision is made for the condition mentioned, then small river communities can have the same advantages as large cities, and likewise have a proportional reduction in the cost of the shipping and receiving of freight.

Need for Adopting Mechanical Methods

To secure these results the following mechanical methods should be employed. The operations of hoisting freight to the required elevation and of conveying and depositing it on the top of the bank, within the door of the box car or directly upon the open car, or upon the river quay, or upon drays on the quay, or in any part of the freight shed, should be performed rapidly, continuously and directly, without delay or congestion and without rehandling. All of this work should be done by machinery, thereby effecting a great saving in man or horse power; and if these operations are so handled at a well-planned terminal, the height of the bank will be no obstacle, and the distance to be covered in conveying freight into the shed and to the rear of the shed by machinery presents no difficulties.

Electricity should be used as power, which may be obtained from the nearest power plant. This power is always available by turning on a switch, and the electric light enables the terminal work to be continued day and night without cessation. Furthermore, when the barge arrives it should not be necessary to hunt up a gang of roustabouts to move the freight. One man per train at the terminal with modern equipment can do the hoisting, conveying, lowering and depositing. No wharf boat with its upkeep and operating expenses would be required. The usual manual labor of handling from barge to boat, rehandling from boat to dray, followed by the long, hard, horse-killing climb to the top of the bank, would be eliminated.

Difficulties Met With Formerly

In cases where merchandise inclines or elevating platforms have been installed, the freight must be first placed upon the incline. When the freight reaches the top it must be rehandled from incline or platform to dray, car, quay or shed. To do this manual labor a number of men must be quickly available, and often they must be kept under continuous pay. At the present time there is great difficulty in obtaining freight handlers even at high wages. The installation, therefore, of mechanical appliances and more progressive methods of operation is absolutely essential. The first step is to erect on the bank at least two wooden frames, one at the water's edge and the second frame about twenty feet inward. Upon the inner sides of these frames there are supported big wooden stringers upon which are placed T-rails, although steel I-beams may be substituted for these wooden stringers. These stringers, with movable cross-tracks, later described, extend from above the barge to within the shed, and their height should be the same as high river bridges, in order to avoid any possible interference by river craft. Railway tracks for co-ordination may be installed in front and, when desired, to the rear of the shed.

The vertical piles used as supports at the water's edge need not interfere with the flow of the river during flood water. Where necessary, they may be protected by pile clusters against ice or driftwood coming down the river.

Fig. 3.—Interior of Terminal Shed, Showing Overhead Tracks

The banks should be protected against erosion from any cause by a row of piles close to the water's edge and riprap or rough paving placed on the face of the bank. Fender piles should be provided along the river against which, at varying levels of the water, the barges can lie. The varying levels of the river do not affect the operation of the terminal—merely a few feet more or less of hoisting are needed in accommodation.

Before work is begun for any new installation, even though it be of the simplest type, a thorough engineering report should be made and plans formulated, as a measure of insurance that the whole terminal be designed, laid out and constructed according to modern terminal principles.

The distance of thirty feet or more between the parallel stringers and T-rails may be spanned by one of two traveling crane bridges of standard design. These bridges are like cross-traveling shop cranes, with the exception that, instead of only the traversing movement of the hoist from one side of the crane to the other, the freight conveying and hoisting machinery will pass along one of the T-rails, and from there upon the movable cross rail or track, and finally along the other side and cross rail to the starting point. Thus the tracks will admit of a complete adjustable loop.

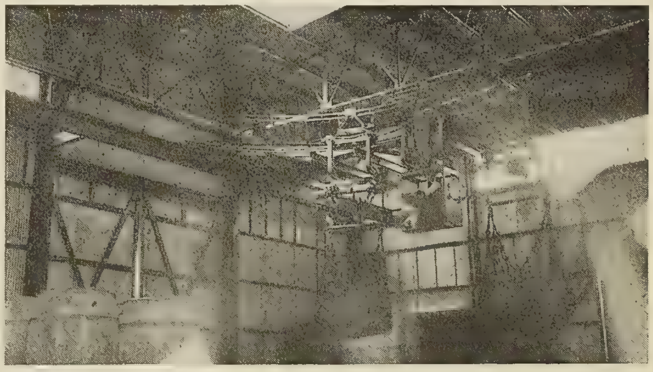


Fig. 4.—Tractor and Trailer Hoists with Nets

The bridges of the cranes support the cross or movable tracks. These tracks have sliding connections with the side tracks, or with the cross tracks, or from the cross tracks to the side tracks at any place. There is formed,

therefore, a movable, adjustable loop from which every cubic foot of space between can be served. Accordingly, freight can be lifted from or placed upon the barge or any square foot of the quay or shed. Also, it may be placed upon any carrier. In addition, the freight can be distributed and tiered to a height three times that which is customary when only man power is used. Only a portion of the barge capacity is usually reserved for the smaller terminals. However, if a whole barge is to be discharged or loaded, the barge can be placed longitudinally and the usual apparatus utilized. Bulk material—coal, sand or rock—or miscellaneous merchandise, as package freight, may be transferred with equal facility to the designated coarse freight space, often at the rear of the shed.

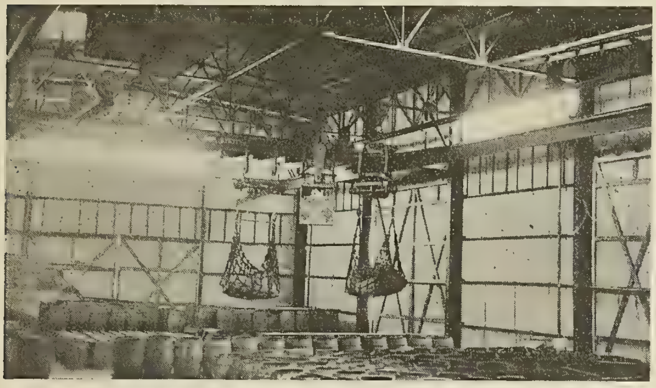


Fig. 5.—Arrangement of Overhead Cranes

A conveyor train, which consists of a tractor corresponding to a locomotive, and with one to four hoists, lifts the drafts of freight by electricity. The tractor has power to draw four carrying hoists. Each electric hoist has a capacity of 100 feet per minute with a load of two tons. The operation of these hoists, whether four or one, is controlled by the one operator in the tractor, who also moves the bridges, which will be described later, to the desired positions. The tractor and hoists are equipped with brakes and safety limits.

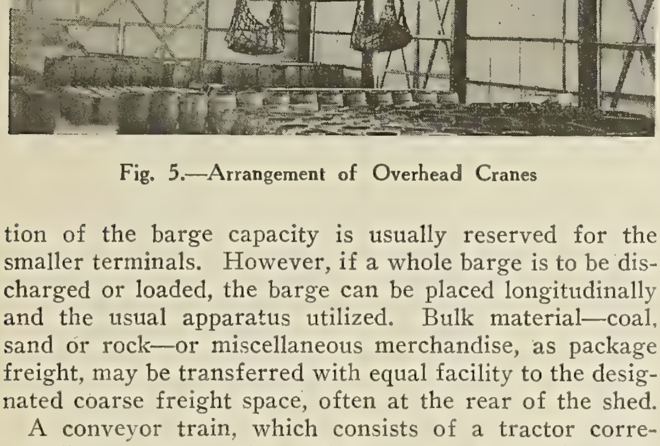


Fig. 6.—Concrete Quay with Oak Protected Wall

The number of hoists in a train, as well as the number of trains at a terminal, may be determined by using the maximum tonnage of the freight, either outbound or inbound, as a basis. One tractor and one or two carrying hoists may be first installed; other hoists or other trains may be added as needed without effecting changes in the original installation, or interruption in the service.

Two bridges are usually installed, since far better results are thus obtained. The initial increase in cost resulting from double installation is by no means commensurate with the advantage gained. Where only one bridge is installed, a loop should be placed at the barge end and each bridge equipped with an electric motor for traveling on the side tracks, as is used for a traveling shop crane.

For the smaller terminals, to reduce the size of the ground area covered, the shed should be made about 30 feet in height and with surface dimensions of 40 feet by 45 feet. This length of 45 feet may easily be extended as far as desired and yet be served by the same machinery. A warehouse for long storage is placed preferably to the rear of the shed. Freight may be taken from the barge to the warehouse by the same machinery which is used to locate it within the shed.

Method of Operating Tunnel

To understand the method of operation fully, the photographs accompanying this article, showing the machinery as installed, should be carefully noted. As soon as a loaded barge comes alongside the quay, the first bridge, with its movable cross track, is moved out over the barge as far as may be required. The hooks of the traveling hoists which have passed out on the cross tracks over the barge are attached to the freight, which is lifted vertically by the electric hoist above the elevation of the top of the bank. Either one or four loads per train are conveyed to the designated place, the movement generally corresponding to the direction of the hands of a watch.

The second bridge, with its movable cross track, is placed either over the open quay space or over or alongside the car tracks. It may also be placed in the shed; over the open space to the rear of the shed; or at the warehouse. Upon this second bridge the tractor travels in its return, the hoist depositing one load and then returning for another.

If there are four hoists, eight or more tons may be conveyed in one trip. Meantime, if there is sufficient freight, two or more trains may also be raising their load and conveying it while the other operation is in progress. A great increase of capacity may be provided at any time by adding trains to operate on the existing loops. It should be remembered also that in many instances the train in its return to the barge can be carrying outgoing freight.

As has been mentioned before, the number of trains needed and the number of hoists per train will depend upon the volume of freight to be discharged and loaded. To avoid delays it has been found advantageous to leave slings in place about the freight and to shift small packages in nets. Everything is then ready for attaching the hoist hooks.

As a distance of one hundred feet more or less in the conveying makes little difference in the cost or time of transference, the speed of traveling with full load being 350 feet per minute, the tracks and shed may be placed sufficiently far back to be upon the elevation of the top of the bank. Consequently filling or quay-wall construction may not in all cases be necessary.

Modifications Required for Special Conditions

For especially heavy weights, above four thousand pounds, two hoists should be attached, which would furnish a lifting capacity of eight thousand pounds. Hoists of greater capacity can be furnished, but experience has shown that a hoist with four thousand pounds lifting capacity is preferable. The spans of the traveling bridges may be made greater if necessary. Spans of fifty feet or more are often installed.

In some cases two sets of parallel tracks are placed side by side with bridges and movable tracks. In this case great transferring capacity is provided, especially when there are several trains for each set of tracks. Two side tracks, the movable cross tracks, tractor and hoists and

shed and surface railway tracks may be considered as constituting a workable, income-producing terminal unit.

The installation which has been outlined here was especially designed to provide smaller communities with mechanical appliances at low initial cost; to secure the greatest speed in discharging and loading barges, and to accomplish the direct raising of the load from the barge to the top of the bank without the usual expensive handling and rehandling. With the equipment mentioned, freight may be immediately placed upon the upper elevation without manual labor; upon the cars; at the door of the cars; upon the drays. As previously mentioned, it may even be taken into the shed and there tiered; or to the areas behind the shed; or to the warehouse, if one is erected. These operations are accomplished rapidly by a continuous succession of wholly mechanical movements

Other possibilities for the use of this equipment will commend themselves to the practical river man. For example, levels lower than the top of the bank, either just above the low level of the river or a third or half way up the bank, may be utilized, in many cases to hasten the discharging or loading, so that the barge may be detained for the least possible time. The loads from the barges may be placed upon these lower levels by the hoisting and movable track machinery, and then, after the barge has departed, be taken by the same machinery to the top of the bank and distributed.

Handling Freight for Early Transshipment

As often happens, a large barge may have freight for early transshipment to smaller boats or barges operating on tributary streams or serving nearby factories. Such freight can be taken from the barge by the overhead hoists, placed on this lower level by the tractors and hoists, and afterwards, by the same machinery, lifted from this low level and placed onto smaller boats, barges or flats for further transportation. Should it be desirable for a portion of this freight to be lifted to the higher level for railway car or dray loading, or to place it in the shed for local transportation, this can be done at any time by the same machinery. Should there be a rise in the water level, loading and unloading can go on as usual.

It is fundamentally necessary to serve area and not lines. If freight be placed only beneath an overhead line track, then it is necessary to have many such tracks, gridironing as it were the area with many overhead tracks and switches. This installation is exceedingly expensive and will require many men to remove the freight from a point directly below the track to permit a second load to be deposited there, or to buttress freight already tiered. The apparatus is very simple to operate. There are no switches in the tracks to be opened or closed, and there are only two side tracks attached to the side posts and to the side columns of the shed. The expense for similar spans and capacity is about the same as for the indispensable shop cranes. The freight may be placed over any square inch of the quay or of the shed floor, and there can be a continual succession of movements without any necessary delay or interference of trains. These, it should be noted, can travel in either direction. The system as described—a combination of the familiar traveling shop cranes, seen in every machine shop, together with the more flexible monorail—will fulfill all the exacting conditions of freight handling and transference at inland river terminals. It provides the area serving advantages of the shop crane as well as the flexibility as to curves, distances and speeds of service of the monorail.

These mechanical appliances, especially adapted to inland river freight transferrence from water to shore, can be installed at the lowest first cost proportional to the results obtained, and can be as rapidly and economically operated, thus removing the objections to high banks and securing the fullest co-ordination between barge and railway car.

At the larger city terminals, when all available land is necessary for the terminal and a large tonnage of freight is to be transferred, the whole area, including the levée, should be utilized. The quay wall and an operating combination of the traveling gentry crane and the adjustable loop system could here be employed to advantage.

Sectioning Great Lakes Ships for Transportation Through Welland Canal

Great Lakes vessels of 6,000 tons and over are cut into sections before they can be brought through the Welland Canal to the St. Lawrence River. One hundred and twelve vessels have reached the ocean by this route during the year. Before the river freezes this total will probably reach 180.

Formerly the use of a dry dock on the Lakes for cutting and another one in the St. Lawrence River for rejoining the vessels was necessary. Last fall, when the need of ships was very pressing, Chairman Edward N. Hurley, of the United States Shipping Board, desired to move as many vessels from the Great Lakes as possible. The board could commandeer any number of vessels desired. Dry docks on the Lakes were sufficient to get a number of boats through, but only two dry docks were available in the St. Lawrence. These were already occupied by ships. Engineers of United States Shipping Board determined to put the halves together while the parts still floated in the St. Lawrence. Twelve were thus put together; four others in drydock, and five ships which were small enough to pass through the canal intact—twenty-one in all were sent out to the Atlantic. The steamers were refitted and strengthened at Atlantic ports to fit them for ocean service.

Details of Sectioning and Rejoining

This year twelve more old ships have been requisitioned and refitted on the Lakes. All of these vessels had to be sectioned and rejoined in the St. Lawrence. The details of the operation as it is accomplished without waste are as follows: Temporary frames of 6 by 6-inch angles are placed around both sections of the ship at the point where she is cut, in such a way that they can be drawn closely together when the ship is rejoined. These angles are bored for 2-inch fitted bolts. The plates of the shell, tank top and decks that do not butt on the special frames are taken off and, where necessary, light patch plates are added to support the special angle frames. When the two sections of the ship are floated together, the ends are trimmed by water ballast until they come together as nearly evenly as possible. Final adjustment is then made by driving drift pins in the 2-inch holes in the special frames. Fitted bolts are then inserted and the ship is thus held firmly together. The plates that have been removed are then put on and riveted. When work above the water line is completed the ship is put in dry dock so that the bottom plates may be put on. Finally, the temporary joining frames are taken out and temporary bulkheads removed. Some of the reconstructed ships need no temporary steel bulkheads. In some cases, however, where the bow section is short, it is necessary to use one temporary wooden bulkhead. Much dry-dock time is saved by this procedure, as compared with the old method of floating the two pieces in dry dock and bringing them together with heavy tackle.

Shipbuilding Costs and Estimates—II*

Careful Reading of Specifications Necessary—Must Have System—List of Items—How to Deal with Individual Items

BY JAMES M. ROBERTSON

INQUIRIES for prices of ships reach a shipbuilder in all forms and from all quarters. Some give the most meager particulars, others are more or less elaborate in detail, while a smaller number of inquiries may require that specifications and plans be submitted with the price, and considerable time and labor will be spent in this direction before the estimate is made.

Estimating to be satisfactorily carried out must be done systematically; otherwise the best results will not be forthcoming. The first step is to glance over the specification and plans to obtain a general idea of the type of vessel, and while so doing to mark off the items which bear on the engineer's part of the work. Most hull specifications contain paragraphs affecting the engineer's estimate of the cost as laid down in the usual demarcation of work between those departments, and the engineers' estimator should be notified at once of these. In the same way the hull estimator usually receives extracts from the engine specification relating to items allowed for in the ship's estimate.

In an important estimate, prices or rates are generally asked from sub-contractors for the more important items of ships' outfit and deck machinery, such as anchors and cables, upholstery, cooking gear, winches, windlass, steering gear, etc. Many of these fittings are specified by shipowners to be supplied by particular makers, so it is safer to ascertain these firms' current prices.

The specification is then read through slowly in conjunction with the plans, and brief notes are made on the estimate sheet of the nature and extent of material to be covered. This part of the work cannot be done too carefully, and the utmost pains must be taken to understand and assimilate what is being read so that no important item is overlooked or omitted.

The technical sheet gives concisely the leading particulars of the proposal under consideration. It is most important, and if carefully filled in enables anyone to obtain at a glance practically all the information considered necessary by a technical man. It forms a very handy reference, and might be used, if necessary, as a basis for making plans and specification of a new vessel or of entirely recasting a proposal.

Steel Work

The steel weight is a very important factor in an estimate, and various methods are in operation for estimating and checking these figures. The following may be mentioned:

Calculating in Detail or Solid Principle.—This method is not the most rapid, but by some it is considered the only system by which correct results can be hoped for, having regard to the constant evolution of ship design.

By coefficient.—$\dfrac{\text{Length} \times \text{breadth} \times \text{depth} \times \text{coefficient (say .3 to .4)}}{100}$

$+ \dfrac{\text{Length of erection} \times \text{breadth} \times 8 \times \text{coefficient (say .1 to .2)}}{100}$

+ Weight to cover owner's requirements over classification rules = Total estimated steel weight.

Use of Curves.—This method is valuable for checking purposes and rough approximate estimates, and is more generally used in these ways, as it is not considered to be sufficiently accurate in itself for important estimates.

Comparative estimating from a vessel already built is a most reliable and quick method for arriving at the steel weight of a typical vessel.

The most suitable basis available, especially as regards breadth and depth, is ascertained, and additions and deductions are made on the basis total to correct differences in arrangement, scantlings, dimensions and fineness between the basis ship and the proposed new vessel.

Stem, Sternpost, Propeller Brackets and Rudder.—Weights are generally based on classification rules for type of vessel under consideration. Particular care must be taken to calculate on the material specified and to cover in the rates per hundredweight any rabbeting, scarph ing, bushing and royalties required in connection with these items.

Rivets and Ironworkers' Labor

Rivets.—Weight averages about 5 percent of steel, except in oil vessels, where it is fully 6 percent.

Ironworkers' Labor.—This is calculated on a rate per ton of steel weight, or on the cube and erection numeral. Curves are often plotted on each of the above bases, and values ascertained therefrom. In other instances values may be built up from comparisons with suitable basis ships as to decks, bulkheads, erections and scantlings. Experience and good basis costs are the main factors in securing good results.

The two most common methods of approximating carpenters' timber are as follows:

1. *Add and Deduct Principle.*—Here a suitable basis boat is taken and prices brought to date. Quantities of different timbers in cubic feet are dealt with, and additions or deductions are made to correct differences between the basis and the proposal. Suitable percentages to cover for waste are added to the additional quantities, and these are then priced out at current rates. Sundry items are usually assumed common to both vessels.

2. *Calculating in Detail.*—Decks, ceilings, sparring, hatches, derricks and bulkheading are all measured from the plan as specified, and after allowances are added varying from 10 percent on decks to 40 percent or 50 percent on awning or boat gears to cover waste in cutting up, the quantities are priced out at rates per square or per cubic feet of sawn timber ready for use.

Timber and Joinery Work

Joiners' Timber.—In a cargo vessel it is customary either to measure up the floor area of the different living spaces and price these at rates per square foot taken from a suitable basis boat, to cover timber, stores and labor, or to run the whole out at rates per room for officers and per man for crew; thereafter in both cases to add suitable amounts for stores, ladders and engine and deck fittings.

In a passenger vessel, however, the pricing of joinery work becomes an arduous undertaking, as, in an important estimate, all the framing, divisions and lining in different classes of accommodation may require to be measured up, and average lineal dimensions obtained for each class of room. These are priced out at suitable rates

* Abstract of a paper read before the Greenock Society of Shipbuilders and Engineers.

per lineal foot, and each item of furniture is valued separately, and a rate per stateroom of each type arrived at. Areas of ceilings and walls of public rooms are also measured up, and priced out at rates based on past results. Floor-area rates, or rates per room for officers, and per man for crew, all calculated from a suitable basis, are used in arriving at the cost of accommodation for the ship's company. All other work, such as galleys, pantries, icehouses, ladders, storerooms, electric light, casings, casing insulation and deck fittings, are dealt with individually according to specified requirements and based on suitable past records of similar work done.

Painting

It is very difficult to estimate painting with any degree of accuracy, as conditions are never twice the same.

The hull proper, which practically includes all work to weather deck, is rated from the steel weight or on the cube and erection numeral for material and wages.

Accommodation.—These are rated per $5.00 value of joinerwork, or priced out at a rate per room.

Bottom Composition.—Usually a rate per square foot on the hull surface.

Cement Work.—Weight is arrived at from suitable coefficient on the square numeral. Wages are based on rate per ton.

Smithwork.—No waste is here allowed on davits.

Plumber Work.—The cost of the wastes in connection with the sanitary fittings is usually arrived at by counting up the number of separate wastes required on the basis of one for each fitting or set of fittings, pricing them out at rates per place for material and wages on past records of work done.

Electrical Work and Canvas Gear

Electrical Work.—In a cargo vessel cost is usually found by counting the number of 16 candle-power lights to be fitted. A rate per light is taken to cover installation. Rate per bell-push and any sundry special items are allowed for separately. Plant is allowed according to requirements based on past records for similar work.

In a passenger vessel inquiries are usually sent out to electric light firms for prices and the most suitable used, or an estimate may be built up in detail from past cost records according to specified requirements.

Canvas Gear.—Area to be covered is measured up and rates per square foot fitted area taken for awnings and tarpaulins. Sails and covers as specified.

Rigging gear, sheet iron, mechanics' work and outfit are all dealt with systematically according to specification, past cost results for similar work and present prices.

The value of scrap (8 to 10 percent of steel weight) is usually deducted from the estimated cost of material.

Employers' liability and National Health Insurance (in those countries which carry this type of insurance) are sometimes included under materials instead of being debited to charges. If so, the amount is estimated as a percentage (usually 2 to 2½ percent) on the total wages.

Finished estimates should be rough checked from curves of actual vessel costs plotted on the cube and erection numeral, as a precaution against serious omissions.

Tender.—The main items which the tender will set forth are briefly as follows: The dimensions of the proposed vessel, speed, the estimated time for completion, price, particulars as to instalment payments and guarantees against defects, any modifications of, or exceptions taken to, specification. Conditions of contract will also be enclosed which will include protective clauses relating to strikes, lock-outs, fire and bad weather, and extension of time for such delays. In a word, all things should be considered.

The Rivetless Steel Ship

The building of a steel ship in three-quarters of the time and at three-fourths the cost heretofore necessary is the latest revolution promised in the sphere of shipbuilding. Instead of the present method of riveting, experiments indicate that steel ships can be entirely put together by electric welding. The Electrical Welding Committee of the United States Shipping Board Emergency Fleet Corporation has formally urged that a 9,300 deadweight ton ship be built by this process. The general sentiment among the body of experts, however, recommends that a smaller ship first be constructed. Meanwhile, a 42-foot electrically welded midship section of a 9,600-ton ship is about to be built for demonstration purposes at the yard of the Federal Shipbuilding Corporation at Kearney, N. J. The methods of assembling and welding to be used are due to A. J. Mason, consulting engineer for the United States Shipping Board.

Smaller electrically welded vessels already in operation and giving good service establish the practicability of the principle. When in June, 1918, England launched a 275-ton barge which was constructed wholly by electric welding, the claim was made that this was the first electrically welded boat ever built. America also claims credit for the first vessel put together by electric welding. Several years ago Mr. Geary, of the Geary Boiler Works, at Ashtabula, Ohio, built a 60-foot tug by the welding process. It has since been in satisfactory service on the Great Lakes. The Electric Welding Committee believes that this boat was the first electrically welded vessel of any size built anywhere in the world. The English barge has also shown good results. It has crossed the channel several times in stormy weather and has given no evidence of leakage. In fact, so successful has it proved that England is now building a 1,000-ton power ship largely by electrical welding.

Electric welding presents certain definite advantages. In a 5,000-ton ship about 450,000 rivets are used; a 9,500 deadweight ton ship requires 600,000 or 700,000 rivets. By the welding process the saving in labor on the minor parts of a ship is reckoned at from 60 to 70 percent. On the hull plating and other vital parts the saving in labor, cost and time of construction is conservatively placed at 25 percent. Moreover, welding means a saving in weight. The weight of rivets on the hull of a 9,500-ton ship would be 500 tons. This weight eliminated, the ship could carry 500 tons more cargo. These estimates are offered by the Electric Welding Committee, of which Professor Comfort A. Adams is chairman.

Mississippi Barge Line

A fair trial of the possibilities of a barge service on the Mississippi River is being made by the Government. The system has already been inaugurated with bi-monthly arrivals and departures between St. Louis and New Orleans.

The once untamed Mississippi, whose reduction to a lighted, patrolled, docile stream Mark Twain commented, now has a federal manager. Last year the Committee on Inland Water Transportation made the preliminary arrangements for the movement of freight on the river. The United States Shipping Board has assisted materially in providing transport, the railroads are ready to co-operate and not obstruct, and now, if ever, the Mississippi should prove its usefulness as a highway.

Two of the three barges are carrying the equivalent of sixty freight cars of grain, and the third carried a mixed cargo on its initial trip. Taking it as a whole, the barge line will be a decided success.

WOODEN TOWBOAT FOR ERIE BASIN TOWING AND HOISTING COMPANY

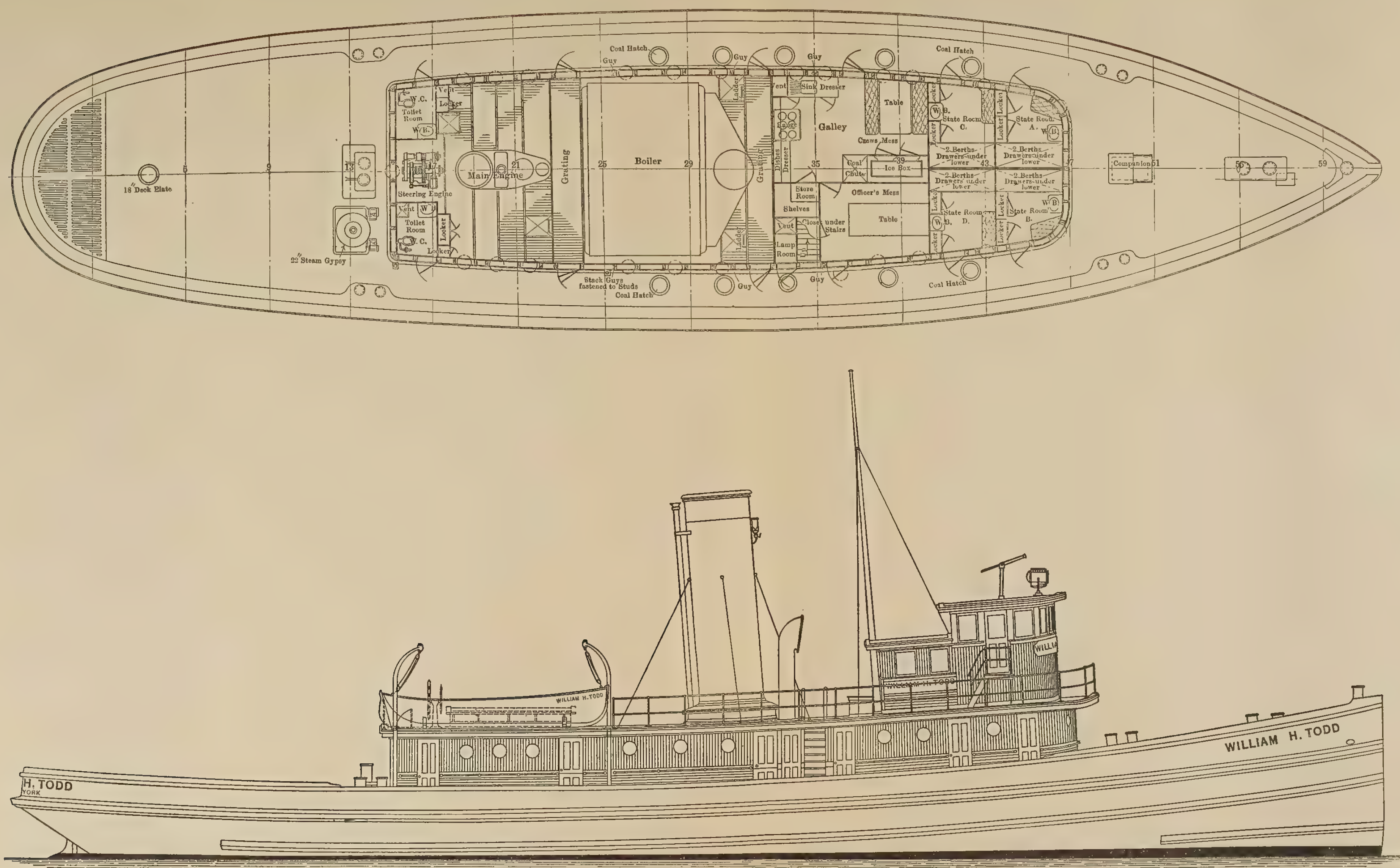


Fig. 2.—Length Overall, 129 Feet 0 Inches; Beam, Outside of Planking, 28 Feet 1 Inch; Load Draft, 12 Feet 0 Inches

Designed by Gielow and Orr, Naval Architects, New York

Plans and Specifications of New Wood Tow Boats

Built for Hard Service—Compound Engine of 750 Horse-power—Scotch Boiler with Three Morrison Furnaces

THE two tugs, *James Dougherty* and *William H. Todd,* now being built for the Todd Shipyards Corporation, of New York, from plans and specifications prepared by Gielow & Orr, will soon be added to the tow boat fleet operating along the Atlantic seaboard. These tugs are being constructed of wood, heavily built throughout, to meet and withstand the hard work required in the tow boat service. From looking over the principal dimensions—length overall, 129 feet; length between perpendiculars, 116 feet 8 inches; beam, outside of planking, 28 feet 1 inch, and draft, fully loaded, 13 feet—their value for coastwise towing and the heavier class of harbor work is established. The character of these boats is plain and substantial, and in every way equal to the best practice.

Eight Watertight Compartments

The hull is divided into eight watertight compartments by means of seven bulkheads, the two in the forward end and two in the after end being of wood, and the three intermediate ones, as well as the fore and aft coal bunkers, being of steel. The forecastle is immediately aft of the collision bulkhead, is 16 feet in length and extends the full width of the vessel. Next comes a water tank having a capacity of 13,000 gallons. Following this is an athwartship coal bunker, with an 18-foot fore and aft length. Immediately aft of this is the fireroom, after which comes the boiler, with coal bunkers along each side of it and the fireroom. The bunker capacity is 135 tons of coal. The engine room is 26 feet in length, followed by a fresh water tank of 12,000 gallons capacity. A lazarette and store room for ropes and gear is adjacent.

The main deckhouse is 64 feet in length, with four officers' staterooms in the forward end. Two mess rooms for officers and men follow, also a galley and large store room for supplies, arranged in the most approved manner with lockers, bins and shelves. Aft of the galley comes the boiler room and fidley, and still further aft the main engine room, 14 feet in length, with a mean width of 14 feet. Aft of this are toilet rooms, space for steering engine and lockers for engineers' supplies. The captain's stateroom and pilot house are on the upper deck. These are quite roomy and are comfortably furnished and fitted in a plain and thoroughly substantial manner.

The engine is of the compound type, with cylinders 18 and 38 inches in diameter and with piston stroke of 30 inches to develop about 750 horsepower. No pumps are worked from the main engines. The units, consisting of a centrifugal circulating pump, a vertical air pump, a bilge pump, a feed pump, a wrecking pump, a pump for fire service, and a sanitary pump, are separate and distinct. The usual bilge ejector and boiler feed injectors are fitted; in fact, the mechanical installation is thoroughly complete and up to date.

Steam at 185 pounds pressure will be supplied by one Scotch boiler 16 feet in diameter and 12 feet in length. This boiler is fitted with three Morrison furnaces, with separate combustion chambers. These vessels are lighted by electricity throughout and are equipped with searchlight and electric running lights. They will be finished and ready for service about the beginning of 1919. Specifications follow:

Specifications

Length overall	129 feet
Length between perpendiculars	116 feet 8 inches
Beam, extreme	28 feet 1 inch
Draft, loaded	13 feet
Displacement at 13 feet	512 tons
Area, midship section	233 square feet
Prismatic coefficient	.656
Bunker capacity	135 tons
Fresh water capacity	25,000 gallons

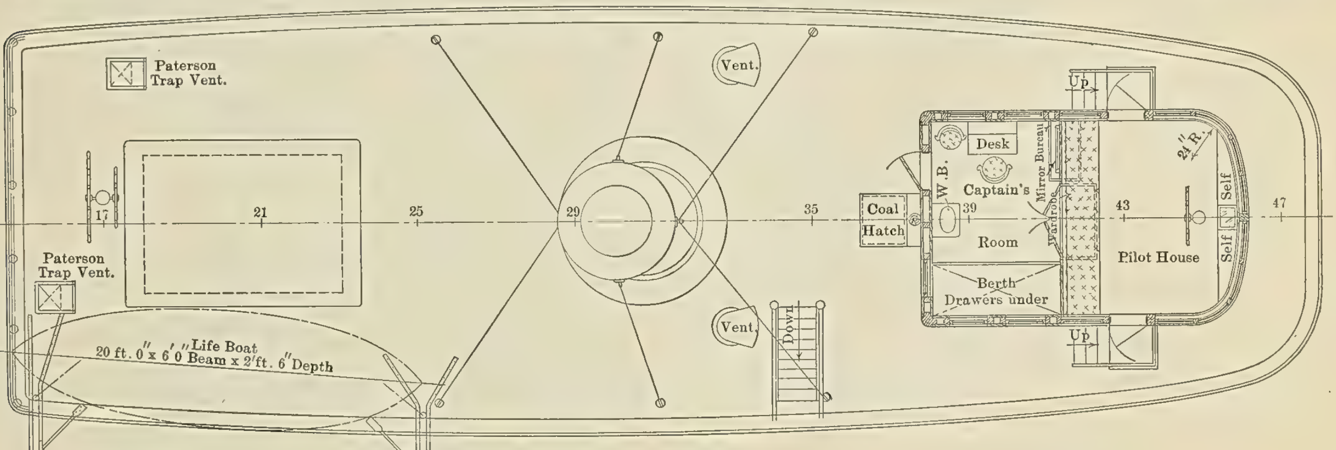


Fig. 1.—Plan of Wood Tug Designed by Gielow & Orr for Todd Shipyards Corporation

Engines

Type	Compound
Cylinder, diameter	18 inches and 38 inches
Stroke	26 inches
Valves, high-pressure piston, double-port slide	Low pressure
Revolutions per minute	140
Indicated horsepower	750
Speed	12 knots
Condensing surface	1,500 square feet
Diameter of piston rods	3⅝ inches
Diameter crank pins	8 inches
Length crank pins	8½ inches
Length connecting rods	65 inches

Propeller

Number of blades	4
Diameter	8 feet 9 inches
Pitch	10 feet 6 inches
Pitch ratio	1.20
Helicoidal area	30 square feet
Circulating pump, centrifugal	8 inches
Capstan, steam	6 inches by 7 inches
Steam steering gear, double engine	4½ inches by 4½ inches
Generating set	5 kilowatts

Boiler

Type	1 single-end Scotch
Pressure	185 pounds
Diameter	16 feet
Length	11 feet 8 inches
Tubes, 348	3 inches
Furnaces, number of	3
Diameter inside	51 inches
Grate area	79.7 square feet
Heating surface	2,613 square feet

Classification Society Necessary to the Merchant Marine

BY "OLD SCOTCH"

The average reader, and, in fact, even the average man connected with the operation or building up of the merchant marine, has but a vague idea as to the functions and great necessity of marine classification societies. In the hope of bringing some light to bear on this subject, therefore, the following elementary description is written.

It is a generally recognized principle that for the conduct of any large business, where the risks to be encountered are too great to be assumed by individuals or corporations engaged therein, it is advisable to divide the losses among all participants in the particular activity, through the medium of insurance societies or organizations, either mutual or general.

Value of Employers' Liability Insurance

Thus we find life insurance societies organized to assume the risk on premature deaths of individuals, thereby providing the means for looking after the dependents of the insured. Again, there are accident insurances to provide for temporary disabilities of bread winners. Fire insurance, probably one of the oldest of the many branches of this activity, protects the individual or corporation from losses due to the ravages of that element. Employers' liability insurances, plate glass insurance, automobile insurance and innumerable other organizations have sprung into being, all based on the proposition of distributing the accidental losses of the individual among many, and thus enabling mankind to develop various branches of industry, where, unaided, the individual would hesitate, or refuse, to assume the risk of development.

The vicissitudes of the sea, among all others, are probably the most diversified. Storm and tempest, reefs and shoals, collisions, fires and other disasters make the successful operation of ships very dependable upon insurance methods.

The investment of money for any purposes is guided by conservatism of the highest type. No one will willingly place his money in any investment unless he can readily foresee, in his own opinion at least, safe returns for its use.

Investors who risk their money in insurance companies depend largely upon the immutable law of averages. The house, or ship, or individual, or thing upon which a risk is taken, must comply with certain rules or regulations, to guard against an undue violation of the laws on which averages are based. In the case of houses or other structures upon land, it must be known how they are built, and whether under certain municipal rules or regulations; for life insurance each must undergo a rigid physical examination to ascertain his condition at the time the risk is taken. All such liabilities are easy to ascertain.

In the case of ships which wander all over the maritime world in quest of business, the ascertaining of pertinent facts upon which to assume an insurance risk is not so easy of accomplishment. "How were they constructed?" and "What is their present condition?" are questions which naturally are uppermost in the minds of those who are asked to risk their money upon the safe arrival of particular vessels.

Regulation and Control a National Matter

The regulation and control of shipping in all countries is a national rather than a local matter, from the very nature of the business in which they are engaged. Governments, as a rule, only take upon themselves part of the responsibility of dictating as to how ships are to be constructed or operated. By certain regulations the state sees to it that precautions are taken to safeguard the lives of its citizens, but the safety of transportation of goods is entrusted almost entirely to private or semi-official organizations, and it is to these that insurance companies must look for information upon which they may assume the risks in which they invest their moneys.

Thus in each great maritime country there has come into being certain so-called "classification societies," whose business it is to superintend the construction and prescribe the rules under which ships are built. They must also, by means of periodical surveys, keep advised as to the condition in which the ships are maintained. An organization of this kind must primarily be one to inspire confidence in the insurance companies and shippers. Nor should it be a money-making institution, though, of course, it should be self-supporting. Its members and agents should be men professionally qualified to pass intelligently upon all technical and practical matters relating to ship building and ship operation. They must also be men of unquestioned integrity and patriotism, fair-minded and diligent. Furthermore, they should have no business connections or affiliations, such as with any concern connected with shipbuilding or operation, in order that their opinions and findings may be unbiased.

American Bureau of Shipping

England, the greatest of all maritime countries, has her British Lloyds, France her Bureau Veritas, and Italy her Registro Navale Italiano.

Quite logically, marine insurance companies prefer to have the classification placed on a vessel, upon which they are to assume a risk, by a society organized and operated by their own nationality. The United States, now about to begin a shipping programme which will place it in the very forefront of maritime powers, fortunately has its own classification society—The American Bureau of Shipping. Started at a time when American shipping activities were at a very low ebb, it has nevertheless maintained its organizations, and at present is well able to undertake the oversight of the immense increase of American shipping in being, under construction, and in contemplation. Insurance facilities form a vital factor in the development and operation of a successful merchant marine. American capital must be enlisted in increasing amounts to satisfy the demands of the trade which is bound to accrue in return for our shipping efforts.

The act creating the Shipping Board, which made pos-

(*Concluded on page 690*)

Analysis of Gas and Gasoline High-Speed Engine Design—II*

Groups of Mechanical Losses Dependent Upon Form of Pipe Work—Volumetric Efficiency and Piston Design

BY HARRY R. RICARDO, B. A.

IN modern high-speed engines every effort is made to obtain the highest possible mechanical and volumetric efficiencies, and these efforts have met with such success that the author can point to examples of quite small engines running at piston speeds as high as 1,800 feet per minute, in which the mechanical efficiency is over 90 percent and the volumetric efficiency over 96 percent, a result which the low-speed school has seldom, if ever, been able to achieve even with the conventional piston speed of only 800 feet per minute. One of the chief problems which the high-speed engine school has dealt with in a very thorough fashion is that of eliminating the mechanical losses, and they have certainly reduced this to a fine art.

The mechanical losses of any internal combustion engine may be divided conveniently into three groups: (1) The losses due to bearing friction and the driving of such auxiliaries as the valve gear, oil pumps, ignition, etc.; (2) piston friction; (3) fluid pumping losses.

The last of these is not, strictly speaking, a mechanical loss at all, but it is customary and very convenient to include it under this head. It is usual to specify the mechanical losses in terms of percentage of the indicated horsepower, but in the author's opinion it is preferable from many points of view, and particularly when the speed is a variable quantity, to classify them in terms of mean pressure per square inch of piston area; that is, in terms of torque rather than power, so that they are directly comparable with the effective mean pressure—all the more so since it is now customary to measure the actual torque in terms of mean pressure per square inch of piston area. This is referred to as the brake mean pressure, i. e., the mean pressure corresponding to the brake horsepower of the engine.

Bearings	0.75 pounds to 1.00 pounds
Valve gear	0.75 pounds to 0.80 pounds
Magneto	0.05 pounds to 0.10 pounds
Oil pump	0.15 pounds to 0.25 pounds
Water pump	0.30 pounds to 0.50 pounds
Total	2.00 pounds to 2.65 pounds

Let us consider the losses included under the first heading. These, of course, are dependent to some extent upon the number of auxiliaries driven from the crankshaft, also upon the number of cylinders between which they are shared, and, to a small extent, upon the weight of the flywheel. The torque equivalent of some of these auxiliaries is dependent upon, and of others, is independent of the speed of rotation. Numerous experiments have been made in order to ascertain the extent of the losses included under this heading, and as a result they have been found to range from 1.5 pounds per square inch mean pressure in the case of a modern 6- or 12-cylinder aero engine up to over 3 pounds per square inch in the case of a heavy single-cylinder gas engine. As a general rule, they may be taken as ranging from 2 to 2.6 pounds per square inch for an average high-speed engine, and may, for a 100-horsepower, six-cylinder engine, be sub-divided. See table above.

* Extract of paper read before the Northeast Coast Institution of Engineers and Shipbuilders.

Piston friction is generally the largest item and is somewhat difficult to account for. In high-speed engines with enclosed crank chambers and forced lubrication the piston may be regarded as being practically oil-borne. Compared with the main bearings, however, the average loading in very much lighter and the rubbing velocity not so very much higher. At first sight, therefore, it would appear that the friction of the piston on the cylinder walls should not be greater than that of an equivalent area of bearing surface in other parts of the engine. That it is, in fact, enormously greater is probably to be accounted for in part by the fact that the motion of the piston is reciprocating and not continuous, and in part by the fact that the lubricating oil is always more or less contaminated and carbonized partly by the escape of a very small quantity of burning gases past the piston rings, and partly by the exposure of the cylinder walls to the high temperature of combustion which tends to carbonize the film of the oil adhering to them. As a result of this contamination the viscosity of the oil is increased enormously, and therefore also its resistance to shear. A very large number of experiments have been carried out by the author and others in order to determine both the cause and extent of piston friction in gas and petrol engines. Briefly, it seems that the main causes are those stated above, and that the extent is almost directly proportional to the average thrust on the cylinder walls and indirectly proportional to the rubbing velocity and the area of surface. It is found that when the area of surface is equal to π times the diameter—that is, when the length and diameter are equal—the piston friction in terms of pounds per square inch can be found from the formula—

$$\frac{\dfrac{\text{Mean fluid pressure}}{4} + \dfrac{\text{2 mean inertia pressure}}{3}}{10}$$

Plus a constant which includes the average pressure on the cylinder walls due to the compression and which depends also, to some extent, upon the number and strength of piston rings. This constant may vary from 1.5 to 4 pounds per square inch, but generally averages about 2 pounds per square inch.

This formula is, of course, purely empirical. It is open to criticism on the grounds that the rubbing velocity is not taken into account, and that, therefore, the resistance of the oil film to shear is assumed to be constant. This, of course, is not the case, but the apparent error is largely corrected by taking very prominently into account the average component of thrust due to inertia pressure, which, of course, varies as the square of the speed.

Fluid Pumping Losses

The extent of these losses depends very largely upon the form of pipework and upon the velocity through the piping and valves. Provided that the pipework, and particularly the intake pipe, is reasonably short, i. e., not more than eight diameters, and that the internal diameter is not less than that of the valve port, also that the valve timing is more or less normal, the loss due to fluid pumping may be taken as dependent upon the velocity through the valve ports. This is approximately true in a diagram in which the horizontal scale denotes the average gas velocity

through the valve ports based on the assumption that the valve is fully open throughout the stroke, and where the vertical scale is the mean pressure of the suction exhaust loop. This curve has been prepared from a very large number of indicator diagrams and from motoring tests, and may be taken as being substantially correct and applicable to any class of four-cycle engine.

It is interesting to compare the mechanical losses of three actual engines, each of about 80 horsepower per cylinder:

1. A Diesel engine bore 16.0 inches, stroke 19.0 inches, normal speed 250 revolutions per minute; piston speed 790 feet per minute; weight of reciprocating mass 994 pounds; mean gas velocity through valves 150 feet per second.

2. A gas engine bore 15.0 inches, stroke 24.0 inches, normal speed 200 revolutions per minute; piston speed 800 feet per minute; weight of reciprocating mass 655 pounds; mean gas velocity through valves 130 feet per second.

3. A petrol engine bore 7.25 inches, stroke 0.5 inches, normal speed 1,400 revolutions per minute; piston speed 1,980 feet per minute; gas velocity through valves 130 feet per second; weight of reciprocating mass 11.35 pounds.

	Friction Losses in Terms of Pounds per Square Inch of Piston Area		
	Diesel Engine Pounds per Square Inch	Gas Engine Pounds per Square Inch	Gasoline Engine Pounds per Square Inch
Bearing, etc..........	3.5	3.0	1.8
Piston friction.......	11.8	7.8	7.2
Fluid pumping loss...	4.5	3.4	3.4
Total............	19.8	14.2	12.4
Brake mean pressure.	75	75.0	118.0
Mechanical efficiency, Percent..........	79	84	90.6

In these figures, in order to make them truly comparative, no account is taken of the air compressor usually fitted to Diesel engines. The indicated mean pressure is taken as 89.0 pounds per square inch in the gas engine and 130.0 pounds per square inch in the gasoline engine.

It may be argued that, while the mean pressure taken in the case of gasoline engines is very nearly the maximum obtainable, that taken in the case of both the gas and Diesel engine is well below the maximum, and that, therefore, the comparison is not a just one. The answer to this is that in both the gas and Diesel engines the cylinder bore is so large that it is not possible to work with higher mean pressures, owing to the excessive heat gradient across the piston and through the walls of the combustion chamber. In the gasoline engine, however, with its small cylinder and thin walls, it is possible to dispose of the heat, and that with the same, or even a smaller, temperature difference between the inside and outside of the cylinder walls and combustion head. Again, in the gasoline engine the mean pressure can only be cut down by throttling the charge as already explained, and not by reducing the mixture strength.

Volumetric Efficiency

It is, of course, obvious that to obtain the best results from any type of internal combustion engine every effort must be made to obtain the highest possible volumetric efficiency, but at the same time it is also of vital importance that the working fluid shall be in a state of the utmost possible turbulence in order to spread and distribute the ignition. This applies with equal, if not with greater, force to Diesel engines, in which the necessary intimate contact of the particles of fuel and air is brought about quite as much by the turbulence of the air within the cylinder as by the spraying of the fuel. In the author's experience, provided that the air in the combustion chamber can be maintained in a state of violent commotion, excellent combustion can be obtained even with very indifferent spraying. The necessary turbulence can be obtained in most cases only by admitting the gas at a high velocity through the inlet valve. The problem, therefore, resolves itself into one of obtaining the highest possible velocity through the valve with the least possible wire drawing, i. e., the nozzle coefficient of the valve opening regarded as an orifice must be as high as possible. Provided that the valve and its passages are designed to give the highest orifice coefficient, the author has found that the best all-round results are obtained when the velocity through the inlet valve is in the neighborhood of 130 feet per second. With carefully designed valve passages and no further restriction or change of direction after the gases have passed the valve, it is possible with this velocity to obtain a volumetric efficiency within 3 percent of the maximum possible figure, while the degree of turbulence is sufficient to give within two or three percent of the highest possible efficiency, i. e., any lower velocity through the valves results in an appreciable drop in the efficiency and power output due to insufficient turbulence, while any higher velocity results in loss of volumetric efficiency, due to wire drawing.

It can be proved that if the swept volume of the cylinder is completely filled with working fluid at atmospheric pressure, the volumetric efficiency in terms of standard pressure and temperature will be approximately 82.7 percent of the swept volume.

Piston Design

Of the individual mechanical features of high-speed engines, by far the most important is the design of the piston, for not only does piston friction constitute the bulk of all the mechanical losses, but the weight of the piston itself is responsible for a very large part of the load on the bearings and for the stresses in the engine structure, due to opposing couples. The design of the piston must be carried out with a view to—

1. Dissipating Heat.—This is met by the use of copper aluminum alloys, whose conductivity is about four times that of cast iron.

2. Reducing Weight.—This, of course, is a question of suitable distribution of the material, so that the loads are transmitted as directly as possible from the crown of the piston to the connecting rod and from the connecting rod to the cylinder wall.

3. Reducing as far as possible the area of surface in contact with the cylinder walls, i. e., cutting down bearing surface where it is not required.

4. Preventing distortion.

Conventional Design of Trunk Piston Defective

The conventional design of trunk piston as used in most single-acting, slow-speed, internal combustion engines is probably about as unimaginative and as defective as it could be. In the first place, the dissipation of heat is catered for by the simple but unenterprising method of piling on masses of metal instead of by attempting to employ a material with a higher conductivity. In the second place, the whole of the pressure from the crown is transmitted through the side walls of the piston and thence to the two extreme ends of the gudgeon pin, with the result that these walls have to be abnormally thick; heavy gudgeon pin bosses must be employed, which results in distortion, and finally the deflection of the gudgeon pin sets up a further distortion of the piston and gives rise to trouble with the gudgeon pin bearing. It is usual also in slow-speed engine practice to make the whole length and circumference of the piston below the piston rings bear

against the cylinder walls, though much of this area is useless as bearing surface and merely serves to increase piston friction. In high-speed engine design, however, every effort is made to reduce the weight and friction, on the one hand by cutting down the weight and bearing surface of the conventional design to the furthest possible limit, and, more recently, by departing from the more conventional form.

Gudgeon Pins and Bearings

In nearly all large internal combustion engines the gudgeon pin and its bearing are a source of more or less anxiety. In small high-speed engines, however, this pin and its bearings seldom, if ever, give the slightest trouble. The main reasons for trouble in large engines appear to be: (1) Distortion of the piston; (2) bending of the gudgeon pin; (3) severe average loading due to the heavy inertia forces.

Of these by far the most important is the bending of the gudgeon pin, due to the fact that the load from the piston crown is delivered to it at its extreme ends and is taken more or less from the center. The author has found that by using a very short gudgeon pin and delivering the load to it at points as close to the center as the connecting rod small end bearing will allow, it is possible to employ a very much smaller bearing surface than usual, and that with considerably less wear than with the convential long gudgeon pin and very wide connecting rod bearings. Further, the wear that takes place on the gudgeon pin owing to the small arc through which the connecting rod rocks is very local and therefore cannot be effectively corrected by rebushing the connecting rod or taking up the bearing.

Wear of Slow and High-Speed Engines

In both high and slow-speed engines the general wear and tear may be measured in terms of the bearing wear, for it may be assumed that the life of the other working parts is at least proportional to that of the bearings. Assuming that the system and supply of lubrication is the same in both cases, the wear may be taken as being proportional to the product of the mean average loading on the bearings and some function of the rubbing velocity, probably about the square root. It is interesting, therefore, to compare the average load on, say, the connecting rod big end bearing of a Diesel engine, a gas engine and a high-speed gasoline engine, all of about 80 horsepower per cylinder, the Diesel engine running at 250 revolutions per minute, the gas engine at 200 revolutions per minute and the gasoline engine at 1,400 revolutions per minute. The projected area of the crank pins in the three examples are: Diesel engine, 94.3 square inches; gas engine, 45.1 square inches; gasoline engine, 11.4 square inches.

The average loading on the crank-pin bearing is made up of (1) the actual fluid pressure in the cylinder, (2) the inertia pressure due to the reciprocating masses, (3) the centrifugal loading due to the weight of the rotating portion of the connecting rod.

These are not all cumulative, but when the necessary corrections have been made the average loading will be the same when the Diesel engine is running at 360 revolutions per minute, the gas engine at 250 revolutions per minute, and the gasoline engine at 1,370 revolutions per minute.

It might be argued that the life and durability of any engine depends upon other parts than the bearings, such, for example, as the exhaust valves and the valve gear generally. In modern high-speed engines, however, provided that the valve gear is properly designed and that multiple valves are used when either the stresses in the gear or the heat flows become excessive, and provided also that the exhaust valves are seated directly onto water-cooled seatings and not, as is sometimes the case, in detachable housing, then trouble with valves is of rare occurrence. Exhaust valves nowadays generally require grinding after about the same number of hours' running in either high-speed or low-speed engines, and breakages have become things of the past.

The question of balancing and the elimination of vibration is, of course, a vital one, particularly in small high-speed engines, most of which are generally fitted to light structures, such as motor cars and aeroplanes. In such cases it is customary to employ four or more cylinders. With four cylinders and cranks at 180 degrees, all the primary forces are balanced and the couples formed by each pair of pistons are opposed to one another so that they exert a bending moment on the structure of the engine but cause no external disturbance. In very high-speed engines it is found that the unbalanced secondary forces due to the angularity of the connecting rods cause a serious disturbance.

Torsional Vibration of Crankshaft

There is yet another and frequently very troublesome source of vibration in six-cylinder engines, namely, torsional vibration of the crankshaft. This is due to the fact that the end of the shaft furthest from the flywheel is, so to speak, wound up when the maximum turning moment is applied to it and released when the pressure is released. At certain speeds this alternate winding up and release coincides with the natural period of the crankshaft, with the result that the shaft vibrates excessively and the reciprocating masses which are attached to it vibrate with it and impart their vibration to the whole structure. Such torsional vibration can be prevented almost entirely by the use of the "Lanchester" damper, which consists of a small flywheel mounted loosely on the crankshaft and connected to it through the medium of a friction clutch. The flywheel rotates at a constant angular velocity, and any relative movement of the end of the crankshaft results in the slipping of the clutch. The damper does not prevent the crankshaft from being wound up and released, but it does effectively prevent it from continuing in a state of vibration. This damper has proved most effective on high-speed engines, and one has recently, at the author's advice, been fitted to a large slow-speed, six-cylinder Diesel engine, which torsional vibration of the crankshaft had proved so troublesome that the engine could not be used. Since fitting the damper this trouble has entirely disappeared, and the engine is now running quite satisfactorily.

Beresford Advocates Younger Admirals

In middle life, when the energy of youth is waning, when the illusions of youth are dissolving, and when the hopes of youth are fading, Admiral Lord Charles Beresford has said, a man tends to relax, both physically and mentally. His choice is determined, and the incentive of ambition has wasted away. Because he no longer makes the effort required to keep him in condition, his muscles become soft, his chest narrow, his shoulders stoop, his latitude increases out of all proportion to his longitude. At the same time, his mental processes become stereotyped; he becomes insusceptible to new ideas, and he begins to lose initiative. It is for this reason that Admiral Beresford has always advocated the making of admirals at a much younger age than the age at which captains are promoted under the present system.

Fig. 1.—Largest Shipyard in the World—Fifty-Two Shipways in Service

Hog Island, the Greatest Shipyard in the World*

Review of the Conditions That Preceded Planning of Yard—Adopting Type and Design of Boat—Troubles Encountered and Overcome—History of the Island

BY W. H. BLOOD, JR.

TO fully comprehend the development, plan and scope of the Hog Island shipyard, one must know the conditions which called for it and the steps which led up to its creation.

On May 7, 1915, the *Lusitania* was torpedoed, and shortly after, during the same year, other British steamers, the *Arabic, Ancona* and the *Persia,* to say nothing of numerous smaller vessels belonging to the allied nations, went sent to the bottom. Many neutral steamers, regardless of nationality or destination, were also sunk, until the total tonnage destroyed in 1915, according to British Admiralty reports, ran up to 1,700,000 gross tons. The record of sinkings for 1916 was nearly 2,800,000 gross tons, and it looked at that time as if Germany might continue to keep up or possibly increase this ratio. It was evident that the world's supply of ships was fast diminishing and there arose an urgent demand that the United States start at once the building of a merchant marine, a thing long talked of but never realized.

Congress, recognizing that such a condition existed, on September 7, 1916, passed an act "To establish a United States Shipping Board for the purpose of encouraging, developing and creating a naval auxiliary and naval reserve and a merchant marine to meet the requirements of the commerce of the United States with its territories and possessions and with foreign countries; to regulate carriers by water engaged in the foreign and interstate commerce of the United States, and for other purposes."

Under the Emergency Shipping Fund Provision of the Urgent Deficiencies Appropriation Act, approved June 30, 1917, the President was, among other things, empowered "to place an order with any person for such ships or material as the necessities of the Government, * * * may require during the period of the war, and which are of the nature, kind and quantity usually produced or capable of being produced by such person." The President was also authorized to exercise the power granted to him and to expend the money appropriated through such agencies as he might determine. This power was delegated to the United States Shipping Board Emergency Fleet Corporation by executive order, and thus a national organization for building merchant ships was established and the expenditure of $500,000,000 for this purpose was authorized.

On April 6, 1917, the Declaration of War against the Imperial German Government was signed by President Wilson.

In May, 1917, General Goethals, who was then general manager of the Emergency Fleet Corporation, discussed with the officers of the American International Corporation of New York the programme then laid down by him of utilizing to their maximum all of the existing ship-

* Read at the twenty-sixth general meeting of the Society of Naval Architects and Marine Engineers, held in Philadelphia, November 14 and 15, 1918.

building yards, and, in addition to this, the construction of new shipyards in which several million tons of ships could be manufactured faster than they had ever been produced.

For several years prior to the war the total output of all the yards of the United States only once exceeded 400,000 deadweight tons per annum, but it was believed that these yards could be crowded up to produce 2,000,000 tons. Still, this was not nearly enough, as it was figured that we needed at least 5,000,000 tons simply to maintain an army of 1,000,000 men in France, to say nothing of getting them over or of increasing the size of this expeditionary force. In other words, it seemed that we must have, simply to supply our own immediate needs, some 3,000,000 tons at the very least, over and above the amount which the established shipyards could produce in a year, and the question was how this tonnage should be secured.

Old Methods of Construction Inadequate

It was admitted that the old methods of construction were inadequate to supply the unprecedented demand, and it seemed that the only way to make good the deficiency was to build a standardized fabricated ship which could be made in quantity. This method of construction contemplated the utilization of going shops all over the country in which the various parts and pieces of apparatus could be made and the shipyard itself could give its entire attention to the assembling of these parts or units.

It was not until June 30, 1917, on which date the Urgent Deficiencies Act was approved, that the Emergency Fleet Corporation was in a position to act upon the tentative plan submitted by the American International Corporation, and, due to changes in the personnel of the Emergency Fleet Corporation and for various other reasons, the execution of this contract was deferred until September 13, 1917. Thus you will see what we have done in a year.

The plan, as it had been outlined by the officials of the American International Corporation, was the construction of a mammoth ship assembling yard and the building of numerous ships, all of the same design. In other words, the scheme was to build a very large manufacturing plant and then to undertake the quantity or "mass production," as our English friends call it, of one type of standardized, fabricated ships.

This meant the design of a simple ship, one in which the plates, sections and angles could be punched and fashioned in the structural steel and bridge shops, for these were the only steel working plants available. The "fabricated ship" was not a new idea, nor was it developed over night, but, as a matter of fact, the germ lay in embryo form for years and only the national crisis caused it to be hatched full fledged to meet the sudden exigency.

Ridicule from the Old-Timers

Many of the old shipbuilders ridiculed the plan of the American International Corporation, saying that the scheme was impracticable, that the shipyard was too large and that the plates punched and bent in so many different shops would not fit. None of those "old-timers" had ever been able to get an order to build a large number of ships all of one design, and the scheme had never been fully tried out, and was therefore something of an experiment.

The officers of the American International Corporation, however, due to their experience in the operation of the New York Shipbuilding Corporation at Camden, N. J., where the parts of the ships were "fabricated" in their own yard, believed that it could be done and offered to construct a new shipyard in which fifty ships could be

Fig. 2.—Hog Island Shore Line Before the Coming of the Shipyard

built at one time, and where a proportionate number could be outfitted at the same time. To build a shipyard with fifty ways was an audacious undertaking, for it was nearly ten times as big as the ordinary shipyard in this country and nearly one-quarter as large as all of the shipyards in Great Britain combined, the reputed capacity of that historic shipbuilding country being only 209 ways.

It was believed that the American International Corporation was better able to undertake this colossal job than any other organization in the country, for the men at the head of it were courageous, were familiar with big affairs, and were willing to stake their established reputations that it could be done. In the first place, the American International Corporation could of itself control sufficient capital to put through almost any enterprise, regardless of its size. It had a capitalization of $50,000,000, and besides this a strong financial backing. Secondly, it could secure the services of the engineering and construction organization of Stone & Webster, inasmuch as Mr. Charles A. Stone, president of the American International Corporation, was the senior partner of the firm of Stone & Webster. This organization had been for many years a leader in executing large engineering and construction undertakings. Thirdly, it could also supply the shipbuilding talent of the New York Shipbuilding Corporation, for the controlling interest in this company had been bought by the American International Corporation, and it was well recognized that it had one of the best developed shipbuilding plants in the country.

Fig. 4.—Winter Operations Preliminary to Building

Had Large Automobile Plants in Mind

The American International Corporation offered to build the shipyard at cost. Its offer was accepted, and it has done better than this: it has not only built a plant costing over $50,000,000 for which it has received no fee whatsoever, but it has put up $1,700,000 of its own money to purchase the land and has paid out of its own pocket overhead expenses already in excess of $1,000,000.

The scheme to build a shipyard five or six times as large as the largest in the country and to assemble or manufacture ships as automobiles are manufactured was a bold one. There were no precedents to follow, much pioneering work had to be done, and many engineering guesses had to be made. There was no time to make complete plans in advance, but the work had to be started at once, and the development of the plans had to be made as the construction proceeded. "Speed" was the essence of the contract and has been the guiding motive from start to finish. The importance of getting the yard finished at the earliest moment is perhaps best realized when one considers that the commercial rental value of the 180 ships under contract, at rates fixed by the chartering committee of the United States Shipping Board, is $460,000 per day, or nearly $14,000,000 per month, to say nothing of their value as a factor in determining the duration of the war.

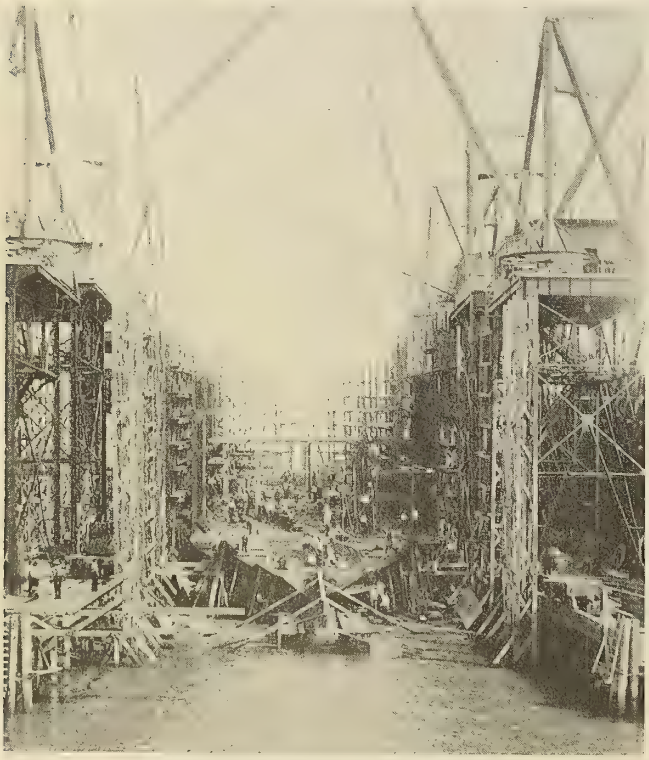


Fig. 3.—Way No. 19, Hull No. 507

By a fortunate coincidence, a company affiliated with the American International Corporation had for months been considering the development of a large port terminal, and in their investigations they had studied every available waterfront property of any considerable size between Boston, Mass., and Baltimore, Md.; knew the location of each of these, the prices for which they could be bought, and many of the physical facts surrounding them. All of this valuable data was immediately available when the contract was signed. The locations between Boston and New York were promptly eliminated because it was obvious that any yard built in that territory would be dependent on one single railroad, which was then already overburdened. Locations directly around New York could not well be considered because other shipyards already established in that neighborhood needed all the men they could get. The most desirable location which presented itself, after eliminating the others one by one, was the tract of land near Philadelphia, on the Delaware River, called Hog Island. The arguments in favor of accepting this location were as follows:

First, the tract of land contained 900 acres, nearly level, entirely vacant, and could be acquired by purchase from one individual and at a reasonable price.

Second, it was on deep water, for the Delaware River

Fig. 5.—View Looking East from Way of Group 2, Showing Pile Driving Operations

Fig. 6.—View Looking East from Way No. 1 Showing Forest of Derrick Masts

has a 35-foot channel directly in front of Hog Island, which runs to the sea.

Third, it was inland, away from enemy attack, being practically 100 miles up the river from the Delaware breakwater.

Fourth, it was on fresh water, for, while there is a tide of some 5 or 6 feet, the water is not even brackish.

Fifth, it was near a large industrial city, from which labor could be drawn and in which some housing facilities could be obtained.

Sixth, it was so located that direct connections could be made with three of the large railroad systems—the Pennsylvania Railroad, the Philadelphia & Reading Railroad, and the Baltimore & Ohio Railroad.

Seventh, it was the nearest available point on tidewater to the steel mills and fabricating shops of Pennsylvania and of the Middle West.

Eighth, it was possible to secure from an already established plant the electric energy needed to run the yard.

Conditions That Changed Daily

In attempting to write a history of the development of Hog Island, it is an almost impossible task to describe chronologically the steps which took place, especially as conditions changed almost daily and as engineering and construction proceeded hand in hand.

The first sketch of the yard is like the ultimate development in only one particular—they both contemplated building fifty shipways. A good-sized shipyard in prewar days contained five or six ways, and this seemed to be a workable unit. It was desired to turn out in this new yard a million and a half deadweight tons per year, and it was thought that when the yard was under full swing four ships per way could be built each year. The conclusion, therefore, was reached that fifty ways, operated in ten groups of five ways each, would be workable.

The experience of the New York Shipbuilding Corporation indicated that it required only about half as long to outfit a boat as to get it ready for launching—this ratio, of course, being more or less flexible—so that to have ample room for outfitting, a wet basin with seven piers, each 1,000 feet long and accommodating four ships, or a total of twenty-eight, was planned and a general utility pier between the ways and the outfitting piers was decided to be advisable.

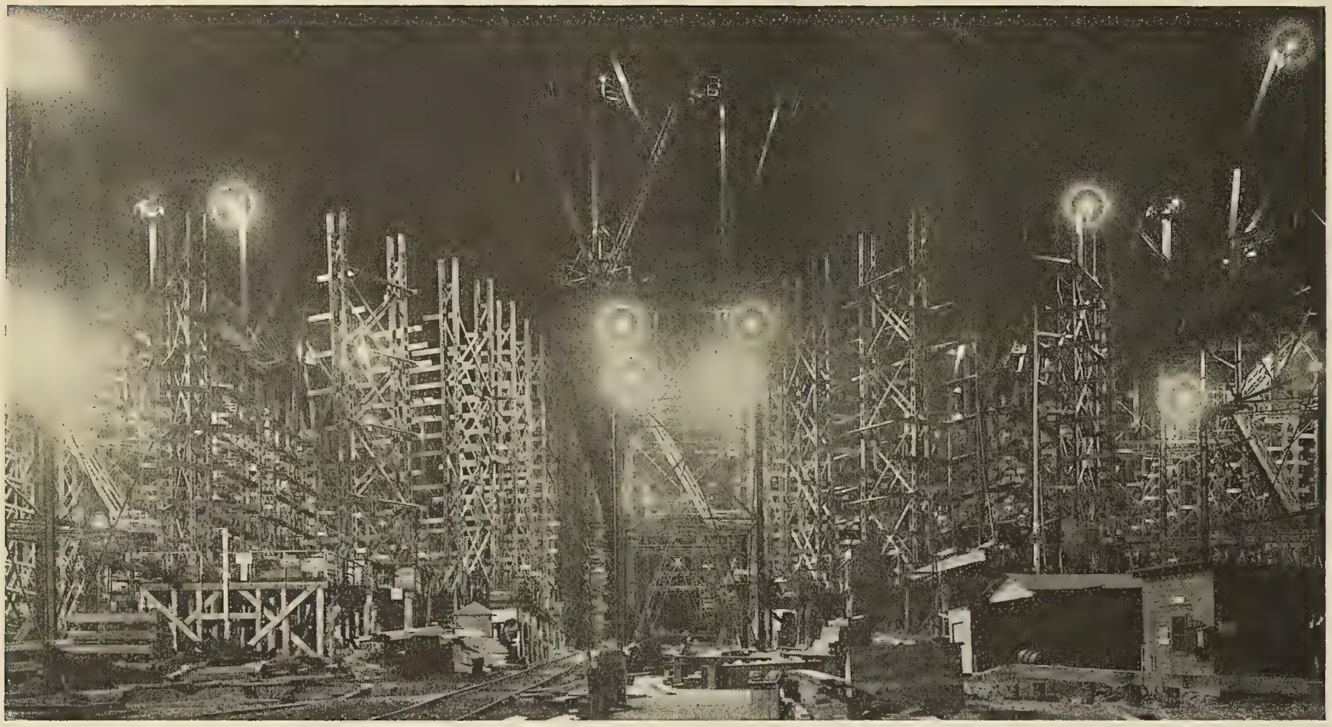


Fig. 7.—Typical Lighting of Shipways at Night That Work May Proceed Uninterrupted

It was expected at the outset that Hog Island would build a vessel of only one type, this being the 7,500-ton, $11\frac{1}{2}$-knot cargo ship, 400 feet long and 54 feet wide, and the original plans and estimates were made on this basis; but the second order for ships given the corporation was for an 8,000-ton, 15-knot combined troop and cargo ship, 450 feet long, 58 feet wide. This change made many alterations in plans necessary, added much to the cost, and prolonged the time of completion of the yard.

Analysis of the Plan of Yard

Looking at the plan of the yard as it is now being constructed, the track layout excites interest, and a study of it shows its simplicity. As ships were to be manufactured in quantity rather than built singly, it was evident that adequate storage space must be provided for piling up plates, sections and other parts, so that they would be ready for immediate use. The plan of storage adopted was that of piling together all plates of the same kind or number, and it was hoped that material for twenty-five boats might always be "in stock," so that the manufacture of ships might go on uninterruptedly, and the storage space was laid out on this basis. Unfortunately, however, this ideal has never been reached, for, while there are sizable piles of some material, the stock of other shapes is still small.

The loaded freight cars come in on a branch of the Pennsylvania Railroad at the northwestern end of the yard from one of the three trunk lines and enter the main classification yard, where they are sorted out. These cars then discharge the steel in one of the two main storage yards—that for the "A" or 7,500-ton boats goes to the "A" yard, and that for the "B" or 8,000-ton boats

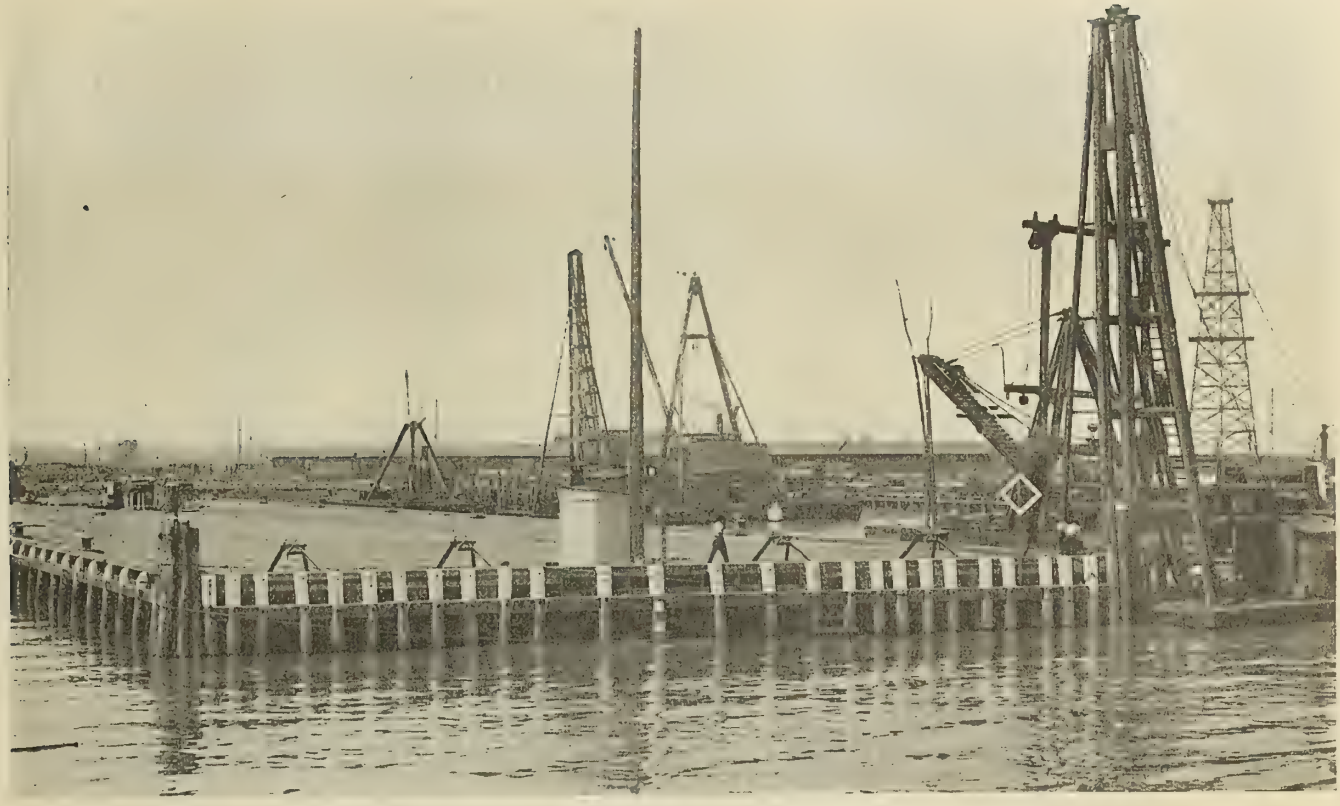


Fig. 8.—View of One of the Piers Where Material is Received for Distribution

Fig. 9.—Early Operations of Driving Piles and Filling In for the Foundations

Fig. 10.—View Showing One of the Mammoth Storage Yards and Intricate Track Layout

goes to the "B" yard. Each shipway, it will be noticed, has a track running down its full length, and each outfitting pier has two tracks on it. Tracks are also carried to each of the warehouses and to all the shops. Then there are also two smaller yards, called the "C" and "D" yards, which are primarily for the storage of material other than steel. The total standard gage track within the shipyard aggregates 80 miles, and the company operates 450 of its own cars, as well as 20 locomotives and 70 locomotive cranes.

A casual observer of the plan of the track layout might criticise the "neck of the bottle" which appears between the "A" and "B" yards. The answer to this criticism is that, while provision has been made for additional tracks at this point, the actual operation thus far shows that they are not needed. It will also be noted that each warehouse and each outfitting pier has a roadway in which materials can be handled by truck. The total roadways within the plant aggregate 18 miles and motor-driven vehicles are used exclusively.

It was stated earlier in this paper that the fifty shipways are divided into ten groups of five each. As a matter of fact, each five ways are operated as independent shipyards, and each yard has its own administration building, service building and tool building. Each way is provided with four steel towers or derricks, and each derrick has two wooden booms, so that there are eight "hooks" per ship, a total of 440. This system of handling material was decided upon because of the difficulties of obtaining an adequate number of traveling cranes with the necessary steel for supporting them. The towers took much less steel, and wooden booms were easily and quickly constructed.

Forty of the shipways are on wooden pile foundations, while ten are concrete ways, erected on concrete piles. The use of concrete gave a diversity factor in construction material and made an admirable fire break in the mile and a quarter of ways.

Between each of the yards there is an air compressor plant, serving two yards, but the supply piping is so connected through the entire shipyard that any individual compressor plant may be by-passed in case of accident. The outfitting piers also have two compressor plants. The total capacity of these plants together is 75,000 cubic feet of air per minute, which makes it the second largest compressor installation in the world, the one at the Rand Mines in South Africa alone surpassing it.

Directly back of the ways buildings and also at the head of the outfitting piers are numerous warehouses in which the lighter, fragile and perishable material is stored. These are one-story buildings and they are each divided into four sections by fire-walls, thus minimizing the conflagration hazard. In addition to this, there is nearing completion a large four-story concrete warehouse, the floor area of which is 400 feet by 172 feet.

Directly in the center of the plant is the group of executive buildings, the principal one of these being the administration building, which houses the president and several vice-presidents and their assistants, the accounting organization, purchasing department, and, besides this, the local representatives of the Emergency Fleet Corporation, who are in direct supervision of the Hog Island plant for the Government.

The adjoining building, originally designated as the engineers' building, is now called the ship administration building. This contains the engineers and the large drafting force. Next in order comes a central garage and then the employment building. The employment department at Hog Island is called the Industrial Relations Department, as the organization has to do not only with the employment of the men but also their welfare and housing. Admission to the employment department is made possible

through a special gate, where no passes are required. All other gates at the yard require a special pass or identification tag before anyone can enter.

Directly opposite the administration building is a cafeteria, in which light luncheons are served to the clerks, foremen and any others who may wish to eat there. Across the street from the ship administration building is located one of the best first-aid hospitals in the country. It is manned by an efficient staff of doctors and nurses. It has an operating room, a first-aid room, a modern X-ray outfit, a ward with twenty beds, a dentist's chair, which is in operation 24 hours a day, and four motor-driven ambulances. There is also in this same group of buildings a fireproof telephone plant, which contains a 22-position switchboard and maintains connections with 2,000 stations scattered throughout the island, this plant being equivalent to that used in an ordinary city of 50,000 population. Adjoining the telephone building is the fireproof reinforced concrete records building. In it all the operating records are kept and the Powers card record system of following all shipments from the time they leave the factory to the time they are placed in position on the ship. Besides the above, there is a guards' barracks, which houses 200 of the guards and also contains a room in which a district magistrate holds court each day. Adjoining this is a small jail. A fireproof brick "bank" building, so called, is also found in this group. It is primarily a depository for the payroll funds and was found necessary, as all employees are paid off in cash each week. In this group, as in all of the other groups of buildings, there is a local central heating plant, which furnishes steam to all the buildings by means of insulated overhead pipes.

Perhaps next in importance are the shop buildings. They are located toward the eastern end of the yard, near the "A" storage yard and back of the shipways. As we approach the shops from the west, we first reach the air tool shop, which is devoted entirely to keeping in repair 6,500 air tools—riveters, reamers, drills and grinders—which are used on the job. Next come the galvanizing and pipe shops and then two machine shops. The largest building in the plant is the plate and angle shop, which is 638 feet by 223 feet. This is arranged with three bays, each bay having two traveling cranes. It is equipped with furnaces and bending tables, rolls, punches, shears, etc. Next is the template shop, whih needs no particular explanation, except the statement that, when building fabricated ships, templates have to be made for every piece of steel entering the ship. The plate and angle correction shop, as its name would imply, was erected more or less as an emergency shop to take care of errors and omissions in fabricating and to act as an insurance against fires, strikes or losses in shipment, which might delay deliveries from outside shops.

The shop plant at Hog Island is comparatively small, as more than 95 percent of all the material entering the ships is being fabricated in outside shops. A few plates are being taken care of in the plate and angle shop. There are smith shops in the group, one for solid work and another for miscellaneous smith work.

Besides the buildings already mentioned are two structures called the ship foundation template buildings. In one of these the complete power plant for the "A" boat has been erected, consisting of three Babcock & Wilcox boilers, a 2,500-horsepower General Electric (Curtis)

Fig. 11.—View Looking North Along Main Street, Which Divides Shipways from Shop Buildings

Fig. 12.—Groups of Hog Island Track Spurs and Main Administrative Buildings

Fig. 13.—Close-Up of Ways, Administrative Buildings and Tool Houses

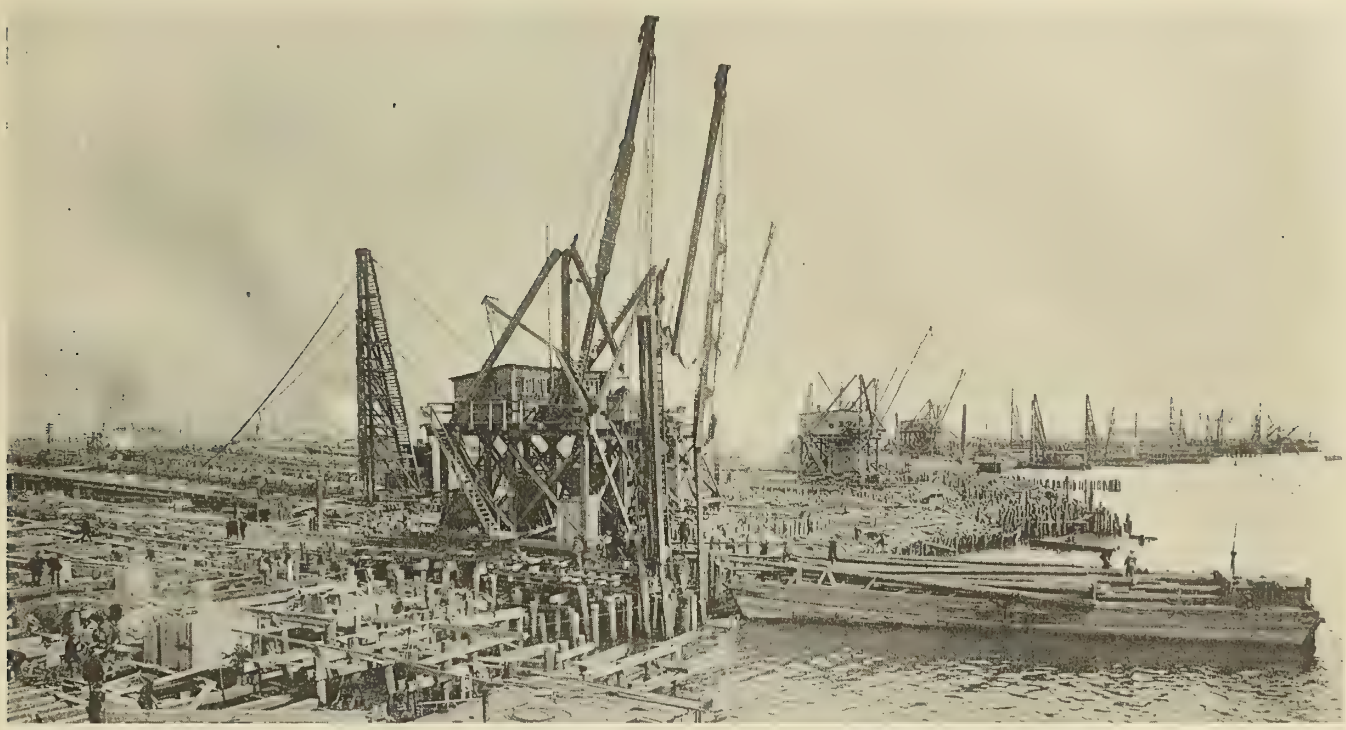


Fig. 14.—View Looking Upstream During Early Days of Intensive Preparation

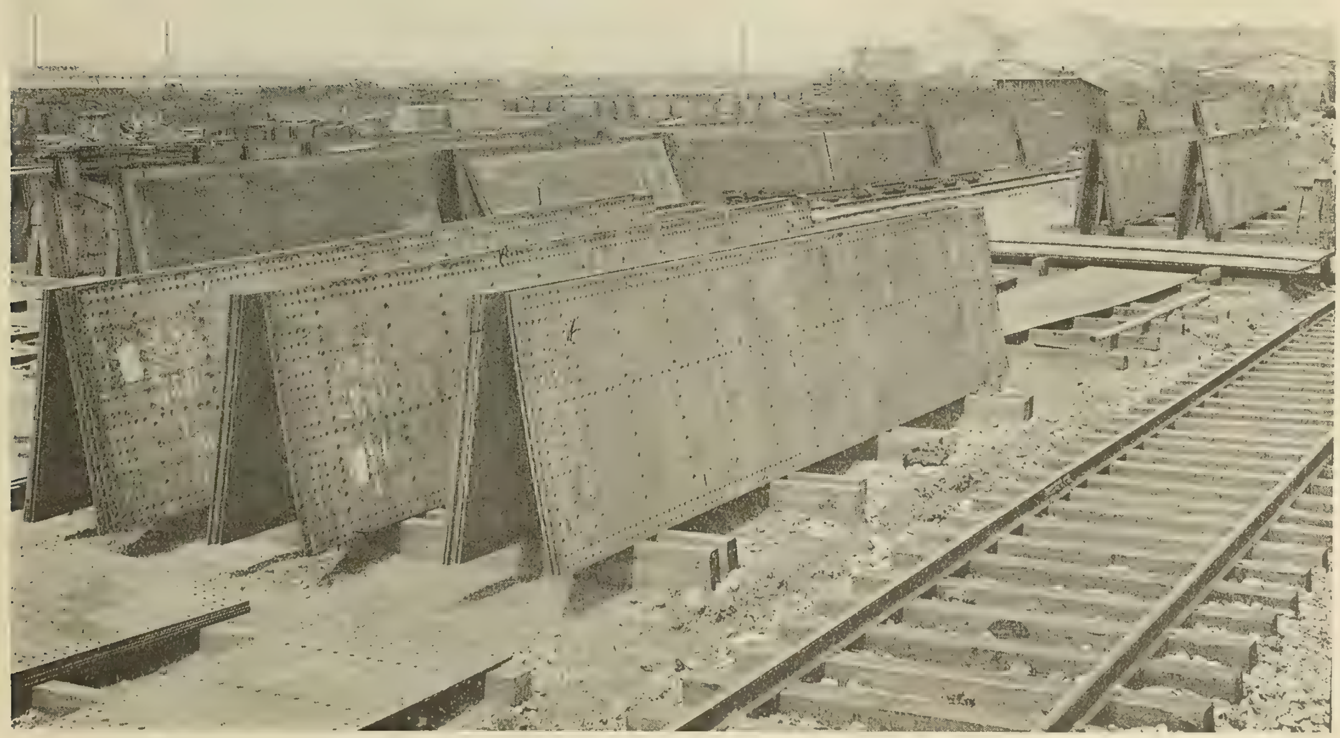


Fig. 15.—Ship Steel Racked in Storage Yard Ready for Immediate Use

geared turbine, with its heater, pumps, condensers and other auxiliaries. This installation was made for the purpose of instructing the installation crews, students and others, and to make sure that all the calculations and measurements of the engineers and draftsmen had been properly made. In like manner, the other ship foundation template building contains a "B" installation, consisting of six Babcock & Wilcox boilers, a 6,000-horsepower General Electric (Curtis) turbine, and the auxiliaries. This entire group of buildings is also heated from a local, central heating plant.

Outside the yard are the living quarters. Here there are barracks for 6,000 men. Each building is a two-story structure and houses 100 men in eight separate wards. These compare most favorably with the army barracks. There is a second guard barracks here which accommodates 200 guards. (A third one is located in the extreme eastern end of the yard.)

Health and Morals of Workmen Considered

The hotel, used principally by the officials, heads of departments, chief assistants and guests, is modern in every respect, and good meals are served here at cost. One of the four fire stations is located here. The department contains 100 men and 16 motor-driven pieces of apparatus. The other three fire stations are located at strategic points within the yard.

There are two large temporary mess halls near the barracks, but these have been practically discontinued, as now the workmen are fed in the service buildings near the ways. During the construction period some 13,000 meals were served daily in these mess halls at 30 cents each. In all, there are at present fourteen eating places on the island, beside the large cafeteria and hotel.

A Young Men's Christian Association building completes the living section of the plant. Its auditorium seats 2,000. It also contains a large gymnasium, twelve billiard tables, locker rooms, shower baths, besides numerous classrooms on the second floor. These buildings are all heated from a local central plant.

Establishing Local Utilities

As Hog Island is outside of the limits of the city of Philadelphia, it was necessary to establish its own local utilities. A domestic water plant, taking water from the Delaware River, together with a filtration and treatment plant, was installed. To distribute this drinking water through the island requires 120,000 feet of piping. A high-pressure piping system for sanitary and fire purposes also covers the island. This requires 90,000 feet of pipe, and raw water is furnished from three motor-driven pumping plants. The ordinary operating pressure is 80 pounds, but on the outbreak of a fire it is run up to 200 pounds. There are 260 fire hydrants systematically located. A complete sewerage system has been put in with two Imhoff tanks and necessary sludge beds. Sewer lines are 73,000 feet in length, and the capacity of the system is ample for a population of 35,000. Electric power is used throughout the yard. The current, purchased from the local company, comes in over a steel tower transmission line at 66,000 volts and goes to a sub-station near the center of the yard. The capacity of this sub-station is 30,000 kilowatt volt amperes, of which 6,000 is reserve, and the connected load is something over 40,000 horsepower. The various electric systems require about 3,000,000 feet of cable, all of which has been placed underground. There are 900 motors in the yard, ranging from 1/30 horsepower to 1,000 horsepower in size. The yard, especially around the ships, is well lighted with flood lights and otherwise. Eighty thousand lamps of all kinds are in use here.

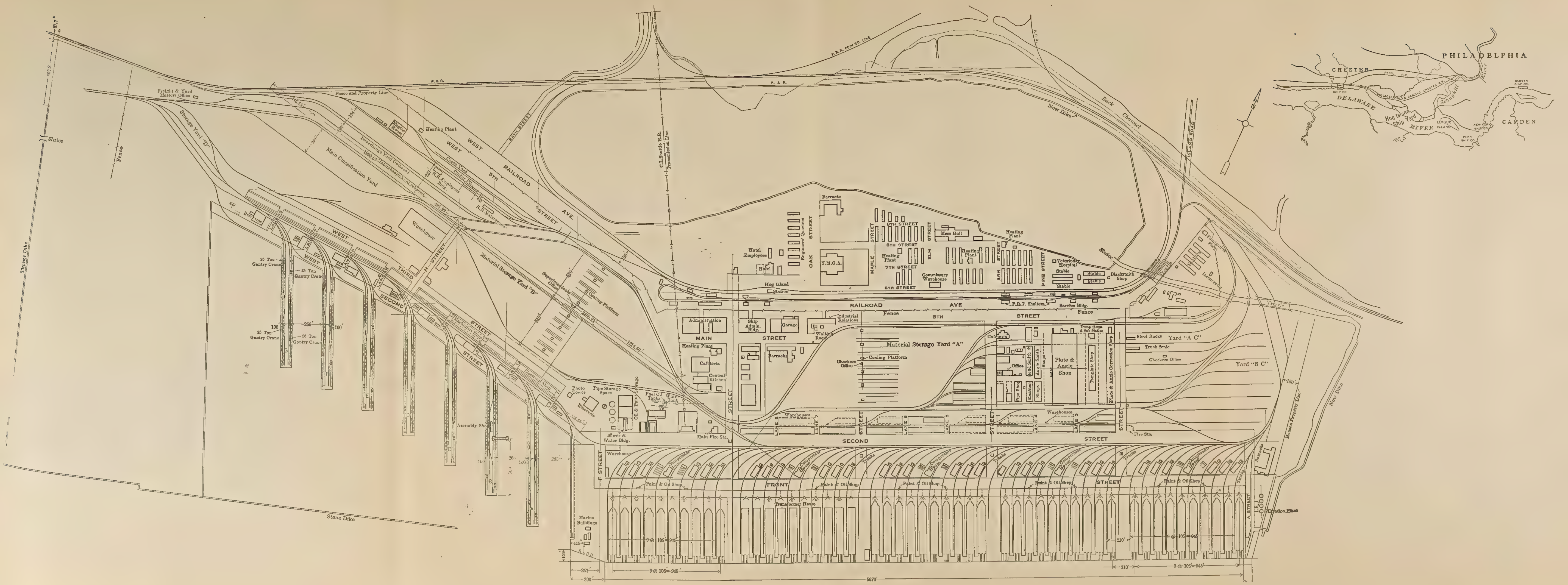
Fig. 16.—Thawing Ground With Live Steam Before Excavating

There are two fuel oil tanks, each holding 100,000 gallons, from which pipes are run to the principal shops where the fuel is used in the furnaces. The present consumption is about 1,200 gallons per day.

To get to Hog Island during the construction period was difficult, as there was no regular transportation to the yard. The nearest lines were a mile away, while others were a mile and a half off. At the present time these difficulties have been removed, as a physical connection has been made with the steam lines and a large loop established within the yard, having three stations, each about half a mile apart. Service is furnished by ten trains, carrying from ten to fourteen cars each. An extension of the Philadelphia Rapid Transit Company now furnishes excellent trolley service direct to the island, and connection is thus furnished with all the lines of this company throughout Philadelphia. The Philadelphia & Southwestern Company, an independent line, also cares for a few thousand men who live in the southern section of Philadelphia. Two large steamboats also run from the wharf at way number 10 direct to the foot of Chestnut

Fig. 17.—Yard Employees Before Main Administration Building

GENERAL PLAN AND TOPOGRAPHY OF HOG ISLAND SHIPYARD



American International Shipbuilding Corporation, Hog Island, Pennsylvania

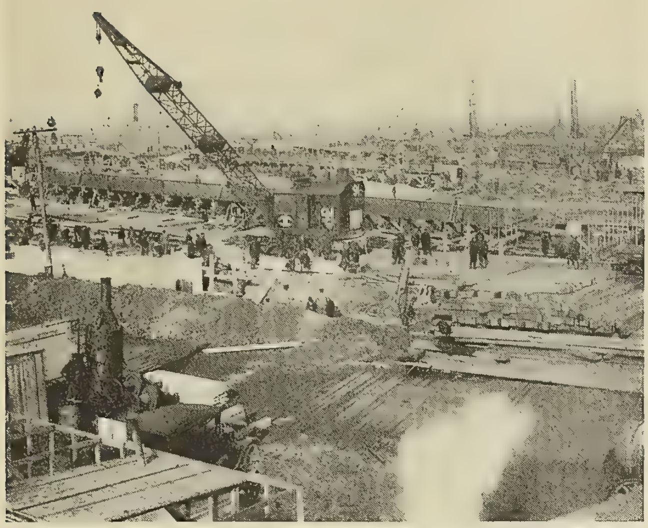


Fig. 18.—Laying Keel of the First Ship

Street, Philadelphia, and one runs across the river to Billingsport, N. J.

The force at the island at the present time is about 30,000, one-half of whom are at work on the ships, some 9,000 are on operation or maintenance of the plant, and 6,000 are still on yard construction. The yard, however, is practically finished, and when the manufacturing of ships is at its height the total force will run between 30,000 and 35,000. The weekly payroll is now about $1,000,000. Standard union wages are paid on construction work, and the ship workers are paid on the basis established by the so-called "Macy Wage Adjustment Board." There is some piece work and this will be extended as the work progresses.

On September 13, 1917, the date on which the contract was signed, Hog Island was a desolate waste. One week later construction began and went on continuously throughout the winter, so that on February 12, 1918, the first keel was laid and on August 5 the first ship was launched, and at this date, October 5, there are forty other ships under construction and three at the outfitting piers.

Overcoming Some Difficulties

As one looks at the shipyard, practically completed in eleven months, it is hard to realize the difficulties encountered in making it a possibility. Last winter was the coldest on record in Philadelphia, and the frost got into the ground to a depth of 42 inches as compared with 24 inches in an ordinary winter, so that it had to be blasted out with dynamite or thawed out with live steam before the piles could be driven. The thermometer for two months was below freezing point most of the time, and on several nights it went below zero and there was no shelter from the wind which swept across the island. The trenches were continually full of water and ice, and, as a matter of fact, hundreds of men had their feet, hands and ears frozen. It took on an average an hour and a half to get to Hog Island, or three hours each day was spent by most of the men on the cars during the short winter days. The wonder is that during this cold weather any work was accomplished.

The labor turn-over during these trying months was, of course, high, but as winter moderated and transportation improved it decreased, so that at the present time the turn-over is only about 35 percent per month. This is, of course, decidedly higher than it should be, but it is simply typical of what is going on all over the country.

Fig. 19.—What Hog Island Looked Like Before the Coming of the Engineers

Even the best of conditions do not prevent the laborers from migrating. The executives, and in fact the entire office staff, worked with great enthusiasm for uncounted hours during the early days and until they were branded as "thieves, profiteers and grafters," when the spirit broke down and the morale of the organization came near going to pieces.

Little by little, however, as the work progressed, as the yard neared completion and as ships began to take shape and finally the launchings began, criticism had died away, and now unbounded praise has taken its place. The *esprit de corps* has come back and everyone is now doing his best. The organization is complete, the entire enterprise is functioning properly and ships will be manufactured at an unheard-of rate—from two to three each week. This is the programme which was outlined at the start, and it will be lived up to. Already three have been launched and are lying at the outfitting piers, where they are fast nearing completion. There are four 35-ton gantry cranes installed on each outfitting pier and a 100-ton bridge crane has been installed, under which any of the ships can ride with masts in place. The outfitting piers are 1,000 feet long and 100 feet wide, and by dredging out some 6,000,000 cubic yards a 23-foot depth of water is being secured.

Present Condition of Yard

The plant is now in condition to turn out a million and a half deadweight tons of ships per year, and, as one of the engineers on the job has said, "It would be no trick at all to get out two million deadweight tons if we could be assured of the steel and the other supplies necessary."

This million and a half tons of ships calls for half a million tons of steel, for 90,000,000 rivets, for 570 boilers, for 700,000 horsepower of steam turbines, and this material must all come in regular order and in an established sequence. It cannot be done, our critics will say, but it is being done. The capacity of the yard at the present time does not depend on the yard itself, but on the shops elsewhere from which it draws its supplies. All the steel plants in the country are being taxed to their utmost, but it is believed that American ingenuity, American enterprise and American push, together with American loyalty, will solve all these difficulties, and that this fleet of 180 ships will be completed and turned over to the Government before August, 1919, the date upon which they are promised.

Need for New Waterways

The need of inland waterways, both for commercial development and for the protection of the United States in time of war, is one of the problems that is concerning shipping men at the present time. Effort is being made to create a sea level canal through the short lakes that may connect our deep water intercostal sounds and bays. The latter comprise at least 85 percent of the Atlantic intracostal canal system, and it requires only the deepening of New Jersey, Delaware and Maryland connecting links—a matter of 15 percent of the whole system—to make for the United States the most valuable intracostal waterway in the whole world. The activity of the submarines has revealed to us the folly in our not having long ago developed these inland waterways. Such a development in accordance with the United States Army Engineers' plans would be much more valuable for commerce than the inland waterways of Central Europe. We need wider waterways and more waterways at once.

Classification Society Necessary to the Merchant Marine

(*Continued from page* 674)

sible our increased merchant marine, very wisely recognized this fact, and the law embodies the following provision:

"It [the Shipping Board] shall examine the rules under which vessels are constructed abroad and in the United States, and the methods of classifying and rating same, and it shall examine into the subject of marine insurance ....and ascertain what steps may be necessary to develop an ample marine insurance system as an aid in the development of an American merchant marine."

It is therefore clearly the policy of this government to aid and abet all facilities necessary for the successful operation of a merchant marine. Of vital importance to "an ample marine insurance system" is the encouragement of an American classification society. Without such a society, backed up by both the government and private interests, it will be very difficult to enlist the aid of American insurance companies.

Heretofore the conditions of American shipping have not been such as to encourage the vital collateral function of a successful merchant marine, but now with the United States leading the world in ship construction it becomes the duty of the government and of every patriotic American to support and help upbuild every means necessary to the successful operation of a great merchant fleet.

In the intense rivalry for foreign trade which is bound to ensue at the close of war, this nation must be fully prepared to enter with its own carriers on the seas, backed up by every essential, operated by its own people and aided in every way by government and private support.

Foreign Impressions of an American Seaman

"The exceptional democratic spirit in the British Navy—rather foreign to our own—caused much wonderment," says an American seaman in a recent issue of the *New York Times*. This sailor had previously seen service in the Eastern Atlantic.

"The jolly and carefree attitude of the British seaman is in marked contrast to the sombre 'Spartan' outlook that is characteristic of our men. I was particularly amazed at the size and power of the British Navy, and especially at the radical characteristics of the British ships.

"I visited a number of German prison camps and noted the excellent quarters of the men, their healthy state, and complacent countenances.

"The great welcome given the Americans by the British was very gratifying. The latter did everything in their power to show us a good time, and made us feel at home in the 'mother country,' as they put it. Their general idea of America was rather vague, however,. In Edinburgh, where I attended church, the minister offered up a very touching prayer for 'the wild Indians in America.'

"The great number of submarines are ever present, also ever harmless when confronted by efficient lookouts on speedy ships.

"There is very good feeling between Americans and Frenchmen and between Americans and British.

"And, finally, I noted the great confidence and new life which the actions of our men have instilled into those rather wearied by many years of hard war."

Control of the Construction of a 5,000-Ton Deadweight Fabricated Steel Ship—IV

Special Schedule for the Ordering and Installation of Machinery and Equipment—Correlation Between Order and Purchasing Departments

BY FABRICATOR

THE desirable method for handling the machinery and equipment of a fabricated steel vessel would be to have the items delivered to the yard a few days before they were to be installed, allowing, of course, enough time for preparation. This procedure would avoid unnecessary tying up of capital and excessive use of storage space. The procedure requires a consideration of the methods of handling equipment, an estimation of the time for which the building slips are to be tied up with each vessel, and a distribution of workmen.

The policy adopted for this size vessel was that, with the exception of the boilers and engines, installation of the machinery and piping and electrical systems would be started as early as possible. In no way, however, would their installation be allowed to interfere with the progress of the hull erection; the equipment and miscellaneous outfits would be put aboard after launching. The line shafting and bearings would be installed just as soon as the condition of the hull would permit. The boilers, main engines and thrust bearing would not be installed until after launching.

To establish dates for delivery of the various items to the yard, an analysis of the operations was made. As it was necessary to build up a yard organization, the outside man was called in and an estimate of the labor required for the various operations was made at the same time. Complete analysis is given herewith on pages 692 and 693.

Referring to the operation analysis. The estimated number of workmen, as entered, is the number of men who could complete that particular operation in ten hours—that is, the man-hours is ten times the number of workmen in each case. The "days to complete" is an estimate of the maximum time which can be allowed to complete the operations. The time is controlled by the launching and trial trip dates. The "day to start" is an estimate of the earliest day on which any operation can be commenced, and is based on the progress of erection and the condition of adjoining or affected jobs.

The labor estimate was based on schedule of estimated performance on the building slips—thusly:

Operation	Standard	Period Hours	Gang Men
Riveting	500 rivets	10	4
Bolters	200 bolts	10	2
Reamers	1,500 holes	10	1
Chippers and calkers......		10	1
Ship fitters...............	12 tons	10	3

All of these standards were based on the record of previous performances, except that of chipping and calking, which was put up to the judgment of the outside man as each operation came up for consideration.

From this estimate, schedules were figured out covering "Piping and Wiring Installation," "Machinery Installation," "Carpenter and Joiner Work," and "Deck Fittings and Miscellaneous Items" to aid the order clerk and purchasing department when specifying and accomplishing deliveries. Four separate schedules were figured out to allow the order clerk to split up his work. Each schedule controlled all of the items required to complete the installations of the machinery or equipment in its classification.

PIPING AND WIRING INSTALLATION ON NINE 5,000-TON DEADWEIGHT STEEL CARGO SHIPS

				Hulls 87, 88, 89			Hulls 90, 91, 92			Hulls 93, 94, 95		
				Material at Yard	Installation		Material at Yard	Installation		Material at Yard	Installation	
Index	Item	Days	Requisition Due		Started	Completed		Started	Completed		Started	Completed
43	Plumbing........................	25	Feb. 25	April 26	May 26	June 20	June 28	July 28	Aug. 22	Aug. 30	Sept. 30	Oct. 25
44	Bilge Piping......................	30	Jan. 28	Mar 28	April 28	May 28	June 1	July 1	Aug. 1	Aug. 11	Sept. 11	Oct. 11
45	Fire Lines.........................	23	Feb. 28	April 29	May 29	June 21	June 31	July 31	Aug. 23	Sept. 3	Oct. 3	Oct. 26
46	Fresh Water Piping...............	19	Mar. 10	May 10	June 10	June 29	July 12	Aug. 12	Aug. 31	Sept. 15	Oct. 15	Nov. 4
49	Electric Wiring..................	30	Feb. 25	April 28	May 28	June 28	July 1	Aug. 1	Sept. 11	Sept. 9	Oct. 9	Nov. 9
57	Deck Machinery Piping............	47	Feb. 16	April 16	May 16	July 2	June 18	July 18	Sept. 4	Aug. 19	Sept. 19	Nov. 5
50	Heating System....................	20	Mar. 3	May 3	June 3	June 23	July 5	Aug. 5	Aug. 25	Sept. 8	Oct. 8	Oct. 28
58	Engine and Boiler Room Piping.....	47	Feb. 16	April 16	May 16	July 2	June 18	July 18	Sept. 4	Aug. 19	Sept. 19	Nov. 5
62	Sea Connections...................	15	Feb. 20	April 20	May 20	June 4	June 21	July 21	Aug. 5	Aug. 22	Sept. 22	Oct. 7

MACHINERY INSTALLATION SCHEDULE ON NINE 5,000-TON DEADWEIGHT STEEL CARGO SHIPS

				Hulls 87, 88, 89			Hulls 90, 91, 92			Hulls 93, 94, 95		
				Material at Yard	Installation		Material at Yard	Installation		Material at Yard	Installation	
Index	Item	Days	Requisition Due		Started	Completed		Started	Completed		Started	Completed
26	Stern Tube........................	3	Jan. 18	Mar. 18	April 18	April 22	May 21	June 21	June 24	July 21	Aug. 21	Aug. 24
27	Bearing and Shafting..............	8	Jan. 25	Mar. 25	April 25	May 3	May 28	June 28	July 6	Aug. 7	Sept. 7	Sept. 15
28	Propell r and Shaft..	2	Feb. 28	April 30	May 30	June 1	July 2	Aug. 2	Aug. 4	Sept. 4	Oct. 4	Oct. 6
30	Fresh Water Tanks......	4	Mar. 5	May 5	June 5	June 9	July 7	Aug. 7	Aug. 11	Sept. 10	Oct. 10	Oct. 14
55	Auxiliary Machinery....	35	Feb. 20	April20	May 20	June 25	June 21	July 21	Aug. 25	Aug. 22	Sept. 22	Oct. 27
53	Boilers...........................	15	Mar. 10	May 10	June 10	June 25	July 12	Aug. 12	Aug. 27	Sept. 15	Oct. 15	Oct. 30
54	Engines...........................	20	Mar. 10	May 10	June 10	June 30	July 12	Aug. 12	Sept. 1	Sept. 15	Oct. 15	Nov. 4
56	Thrust Shaft and Bearing	10	Mar. 12	May 12	June 12	June 22	July 14	Aug. 14	Aug. 24	Sept. 17	Oct. 17	Oct. 27
59	Deck Machinery......	15	Mar. 5	May 5	June 5	June 20	July 8	Aug. 8	Aug. 23	Sept. 11	Oct. 11	Oct. 26
60	Induced Draft.....................	6	Mar. 10	May 10	June 10	June 16	July 12	Aug. 12	Aug. 18	Sept. 15	Oct. 15	Oct. 21

Operation Analysis and Labor Estimate for One 5,000-Ton Deadweight Fabricated Steel Ship

LAUNCH 60th DAY AND DELIVER 90th AFTER LAYING KEEL

Item	Number of Pieces	Weight, Tons	Operations	Men	Days to Complete	Day to Start
1 Flat Plate Keel (incl. Straps)	15	29.4	Laying on Keel Blocks Fitting and Bolting-up (700) Reaming Riveting (2,700) Calking	9 18 2 18 6	1	1st
2 Vertical Keelson	6	17.9	Placing on Flat Plate Keels Fitting and Bolting-up (600) Reaming Riveting (2,800) Calking	3 6 2 18 3	1	1st
3 Bottom Shell Garboard to Bilge, both included	202	176.0	Placing on Ways Fitting and Bolting-up (21,000) Reaming Riveting (62,000) Calking	45 105 41 496 20	5	1st
4 Stem	2	2.6	Placing Bolting and Fitting (150) Reaming Riveting (540) Calking	3 2 2 4 2	1	6th
5 Stern Frame	1	9.5	Placing Fitting and Bolting (500) Reaming Riveting (2,000) Calking Boring	3 6 3 16 4 6	1	7th
6 Floors and Intercostals	600	219.5	Placing Fitting and Bolting (14,000) Reaming Riveting (46,000) Calking	63 140 30 368 5	7	8th
7 Tank Top Plating (includes Doublers, Manhole and Heater, Rings and Covers)	88	132.6	Placing Fitting and Bolting (7,000) Reaming Riveting (30,000) Calking	36 70 10 200 15	6	12th
8 Bulkheads	373	123.1	Placing Fitting and Bolting (6,000) Reaming Riveting (24,000) Calking	30 60 16 200 5	4	19th
9 Frames (includes Channel Web and Angle Frames and Pillar)	289	242.0	Placing Fitting and Bolting (12,500) Reaming Riveting (50,000) Calking	63 140 33 400 3	7	25th
10 Shaft Foundation	18	2.9	Fitting and Bolting (150) Reaming Riveting (600) Calking	2 1 8 3	3	17th
11 Shaft Alley	86	38.1	Placing Fitting and Bolting (3,000) Reaming Riveting (8,000) Calking	9 30 4 64 6	6	30th
12 Second Deck Beams and Girders (includes Deep Tank Top Intercostals)	81	17.5	Placing Bolting (900) Reaming Riveting (4,800)	6 8 3 36	3	30th

Item	Number of Pieces	Weight, Tons	Operations	Men	Days to Complete	Day to Start
26 Stern Tube	3	......	Fitting and Bolting Riveting Calking	4 4 1	3	10th
27 Line Shafting and Spring Bearings	......	......	Machining and Fitting	32	8	17th
28 Shaft and Propeller	2	......	Machining and Fitting	24	2	51st
29 Auxiliary Machinery Foundations	311	26.3	Placing Fitting and Bolting (1,500) Reaming Riveting (6,000) Calking	9 15 4 48 14	11	55th
30 Fresh Water Tanks	......	......	Fitting and Bolting Reaming Riveting Calking	6 2 64 14	4	58th
31 Mast Foundations	80	14.5	Placing Fitting and Bolting (1,000) Reaming Riveting (4,000) Calking	6 10 3 32 3	6	50th
32. Cementing	......	......	Cementing	40	14	45th
33 Bottom and Shell	......	......	Chipping Painting	84 48	15	35th
34 Chocks, Bitts, Cleats, Mooring Rings, etc.	......	......	Fitting and Bolting Reaming Riveting	41 3 4	12	53rd
35 Derricks	......	......	Rigging	18	10	71st
36 Vents and Gear	32	......	Fitting and Bolting Reaming Riveting Machining	16 2 4 6	11	63rd
37 Gun Platforms	98	10.1	Fitting and Bolting Reaming Riveting (2,000) Calking	5 2 16 2	15	46th
38 Masts	......	......	Rigging	6	5	66th
39 Skylights	......	......	Fitting and Bolting	10	10	66th
40 Wood Decks	......	......	Carpentering Calking	48 40	13	64th
41 Deck Shelters and Railings	......	......	Fitting and Bolting Reaming Riveting	42 4 16	10	65th
42 Chart House, Bridge, Wheel House and Wireless Room	......	......	Fitting and Bolting Reaming Riveting	22 6 16	20	71st
43 Plumbing	......	......	Fitting	104	25	47th
44 Bilge Piping	......	......	Fitting	96	30	20th
45 Fire Piping	......	......	Fitting	105	23	50th
46 Fresh Water Piping	......	......	Fitting	35	19	62nd
47 Ladders and Platforms	......	......	Machining	80	13	58th

Item	Number of Pieces	Weight, Tons	Operations	Men	Days to Complete	Day to Start
13 Upper Deck Beams.........	22	101.1	Placing	27	4	33rd
			Bolting (6,000)	60		
			Reaming	15		
			Riveting (22,000)	176		
14 Shell Plating (Strakes F-G-H-J and L(	180	271.4	Placing	72	7	30th
			Fitting and Bolting (18,000)	180		
			Reaming	40		
			Riveting (56,000)	448		
			Calking	101		
15 Second Deck Plating (includes Deep Tank Top)	51	9.2	Placing	3	2	32nd
			Fitting and Bolting (1,000)	10		
			Reaming	3		
			Riveting (4,000)	32		
			Calking	15		
16 Upper Deck Plating (includes Doublers)	106	118.6	Placing	27	6	37th
			Fitting and Bolting (6,000)	60		
			Reaming	20		
			Riveting (24,000)	200		
			Calking	25		
17 Bulwarks (includes Plating and Stiffeners)	179	36.0	Placing	9	4	40th
			Fitting and Bolting (2,000)	20		
			Reaming	5		
			Riveting (8,000)	64		
			Calking	16		
18 Fo'cstle and Poop Structure Framing, Plating	78	72.2	Placing	18	3	43rd
			Fitting and Bolting (2,600)	26		
			Reaming	10		
			Riveting (13,000)	120		
			Calking	4		
19 Bridge Deck House (Framing and Decking and Side Plating)	88	54.0	Placing	15	3	43rd
			Fitting and Bolting (2,400)	24		
			Reaming	10		
			Rivetting (12,000)	96		
			Calking	30		
20 Hatch Coamings...........	248	40.7	Placing	9	4	45th
			Fitting and Bolting (15,000)	15		
			Reaming	6		
			Riveting (9,000)	72		
			Calking	8		
21 Engine and Boiler Casings and Coal Chute	178	27.3	Placing	9	5	38th
			Fitting and Bolting (1,000)	10		
			Reaming	3		
			Riveting (5,000)	40		
22 Galley, Mess Room and Cold Storage Casings	131	8.9	Fitting and Bolting (800)	8	2	45th
			Reaming	2		
			Riveting (3,000)	24		
			Calking	4		
23 Engine and Boiler Foundations	85	29.7	Placing	9	6	18th
			Fitting and Bolting (2,000)	20		
			Reaming	5		
			Riveting (7,000)	60		
			Calking	12		
24 Boat Deck Houses..........	61	19.5	Placing	6	4	50th
			Fitting and Bolting (1,000)	10		
			Reaming	3		
			Riveting (4,000)	32		
			Calking	8		
25 Deck House Bulkhead.......	467	57.2	Placing	12	8	46th
			Fitting and Bolting (2,000)	20		
			Reaming	6		
			Riveting (9,000)	72		
			Calking	14		

Item	Number of Pieces	Weight, Tons	Operations	Men	Days to Complete	Day to Start
48 Cabin Joiner Work..........	....	....	Joining	80	20	56th
			Carpentering	100		
49 Electric Wiring............	....	....	Wiring	120	30	50th
50 Heating System...........	....	....	Fitting	96	20	56th
51 Davits and Fittings.........	....	....	Rigging	144	20	60th
52 Cargo Battens and Clips....	....	....	Carpentering	100	10	65th
53 Boilers....................	....	....	Rigging	40	15	63rd
			Pipe Fitting	4		
			Machining	10		
			Helping	20		
54 Engines....................	....	....	Rigging	36	20	63rd
			Pipe Fitting	10		
			Machining	90		
			Helping	90		
55 Auxiliary Machinery........	....	....	Rigging	36	35	40th
			Pipe Fitting	36		
			Machining	90		
			Helping	90		
56 Thrust Shaft and Bearing....	....	....	Rigging	36	10	65th
			Pipe Fitting	5		
			Machining	12		
			Helping	12		
57 Deck Machinery and Steam Exhaust Piping	....	....	Pipe Fitting	24	47	37th
58 Engine and Boiler, Steam and Exhaust Piping	....	....	Pipe Fitting	208	47	37th
59 Deck Machinery............	....	....	Rigging	54	15	58th
			Machining	25		
			Helping	50		
60 Induced Draft.............	....	....	Rigging	48	6	64th
			Pipe Fitting	50		
			Machining	24		
			Helping	24		
61 Engine and Boiler Room Gratings, Floors and Ladders	....	....	Rigging	12	20	58th
			Pipe Fitting	4		
			Machining	18		
			Helping	18		
62 Sea Connections...........	....	....	Pipe Fitting	30	15	40th
			Machining	48		
			Helping	48		
63 Stack and Breachings.......	....	....	Rigging	30	10	70th
			Helping	48		
			Machining	48		
64 Lagging and Coverings......	....	....	Pipe Fitting	18	30	50th
65 Preparation...............	....	....	Carpentering	20	7	52nd
			Rigging	15		
66 Launch....................	....	....	Carpentering	20	1	60th
67 Hotel Equipment...........	....	....	....	....	10	70th
68 Trial.....................	....	....	....	....	5	82nd
69 Delivery..................	....	....	....	....	1	90th

CARPENTER AND JOINER WORK AND EQUIPMENT ON NINE 5,000-TON DEADWEIGHT STEEL CARGO SHIPS

				Hulls 87, 88, 89			Hulls 90, 91, 92			Hulls 93, 94, 95		
Index	Item	Days	Requisition Due	Material at Yard	Installation Started	Installation Completed	Material at Yard	Installation Started	Installation Completed	Material at Yard	Installation Started	Installation Completed
40	Wood Decking	13	Mar. 11	May 11	June 11	June 26	July 13	Aug. 13	Aug. 26	Sept. 16	Oct. 16	Oct. 29
48	Cabin and House Joiner Work	20	Mar. 5	May 5	June 5	June 25	July 7	Aug. 7	Aug. 27	Sept. 10	Oct. 10	Oct. 30
52	Cargo Battens and Clips	10	Mar. 13	May 13	June 13	June 23	July 15	Aug. 15	Aug. 25	Sept. 18	Oct. 18	Oct. 28
65	Preparation	7	Feb. 29	April 29	May 29	June 5	June 31	July 31	Aug. 7	Sept. 7	Oct. 3	Oct. 10
67	Hotel Equipment	10	Mar. 18	May 18	June 18	June 28	July 19	Aug. 19	Aug. 29	Sept. 22	Nov. 22	Nov. 1

DECK FITTINGS AND MISCELLANEOUS ITEMS ON NINE 5,000-TON DEADWEIGHT STEEL CARGO SHIPS

				Hulls 87, 88, 89			Hulls 90, 91, 92			Hulls 93, 94, 95		
Index	Item	Days	Requisition Due	Material at Yard	Installation Started	Installation Completed	Material at Yard	Installation Started	Installation Completed	Material at Yard	Installation Started	Installation Completed
32	Cementing	14	Feb. 25	April 25	May 28	June 18	June 26	July 26	Aug. 9	Aug. 27	Sept. 27	Oct. 11
33	Painting Bottom	15	Feb. 14	April 14	May 14	May 29	June 16	July 16	July 31	Aug. 17	Sept. 17	Oct. 2
34	Chocks, Bitts, etc.	12	Feb. 25	April 25	May 25	June 6	June 27	July 27	Aug. 8	Aug. 29	Sept. 29	Oct. 11
35	Derricks	10	Mar. 18	May 18	June 18	June 28	July 20	Aug. 20	Aug. 30	Sept. 23	Oct. 23	Nov. 2
36	Vents and Gear	11	Mar. 10	May 10	June 10	June 21	July 12	Aug. 12	Aug. 23	Sept. 13	Oct. 13	Oct. 26
38	Masts	6	Mar. 13	May 31	June 13	June 19	July 15	Aug. 15	Aug. 21	Sept. 18	Oct. 18	Oct. 24
39	Skylights	10	Mar. 13	May 13	June 13	June 23	July 15	Aug. 15	Aug. 25	Sept. 18	Oct. 18	Oct. 28
41	Deck Shelters and Railings	10	Mar. 12	May 12	June 12	June 22	July 14	Aug. 14	Aug. 24	Sept. 17	Oct. 17	Oct. 27
47	Ladders and Platforms	13	Mar. 5	May 5	June 5	June 18	July 7	Aug. 7	Aug. 20	Sept. 10	Oct. 10	Oct. 23
51	Davits and Fittings	20	Mar. 7	May 7	June 7	June 27	July 9	Aug. 9	Aug. 29	Sept. 12	Oct. 12	Nov. 2
61	Engine and Boiler Room Gratings, etc.	20	Mar. 6	May 6	June 6	June 26	July 8	Aug. 8	Aug. 28	Sept. 11	Oct. 11	Oct. 31
63	Stack and Breeching	10	Mar. 17	May 17	June 17	June 27	July 19	Aug. 19	Aug. 29	Sept. 22	Oct. 22	Nov. 2
64	Lagging and Coverings	30	Feb. 26	April 27	May 27	June 27	June 29	July 29	Aug. 29	Aug. 1	Sept. 1	Oct. 1

The date for delivery of the requisitions to the purchasing department and for delivery of material at the yard was fixed and rigidly adhered to. The order clerk inserted the delivery dates on the requisitions, and the purchasing department, which was responsible for deliveries, was provided with copies of the schedules. As this phase was "up to" the men in the purchasing department, they had the right to call for immediate action, on the part of the order clerk, on such items as were difficult to secure, or as required special attention.

Since there was nothing of especial interest about the requisitions or purchase orders, they will not be covered in detail here. The method of using them may be suggested, however. The order clerk was under the naval architect, who approved all requisitions before they went to the purchasing agent. The requisitions bore the ordinary accounting information, i. e., the quantity or number of items required, the description and specifications in a general way, with just enough technical information to allow the purchasing agent to submit an intelligent request for quotations. The purchasing department maintained the usual follow-up on its requests, and with the quotations closed they would be submitted to the naval architect for approval and recommendations. A copy of the purchase order was sent to the naval architect and the quotations were returned by him to the purchasing agent.

The yard was kept posted on the receipt of all material, except steel, by the regular receiving report, made out by the receiving clerk after it had already passed through the hands of the order clerk, who inserted the hull number or job number on which the item was to be used. No special features were incorporated in this report. In fact, "red tape" was whitewashed wherever possible. The method of checking steel receipts will be covered in a subsequent issue.

Test of Rivetless Ships

Some interesting particulars relative to the test vessel of welded construction which is being built at the Central Shipbuilding Plant, Newark, N. J., for the Emergency Fleet Corporation are worthy of being reproduced. It has been necessary to design a ship to suit the material available without encroaching on that needed for the regular ship construction at Newark, and hence the hull will have the outline dimensions and strength conforming to the ships there building. The work will, however, be carried out at a site apart from the slipways, so as not to interfere with the ordinary work of the yard.

Briefly, the programme is to assemble a hull rapidly by spot welding, so that the structure becomes a house in which the work may go forward in all weathers and also at night. The spot welds are to be about 10 inches apart, so that the structure is sufficiently strong to hold its shape while the work is completed by arc-welding all seams to ensure strength and to render the work watertight. Three-quarters of the entire structure will be welded, and the other quarter riveted in the ordinary way, so that the tests of strength will afford a basis of comparison. Moreover, apart from strength considerations, it is recognized that welding offers a great field for lightening a ship, and it is hoped that ultimately 10 percent of the steel may be eliminated. The problems of fitting in place the parts of a hull are almost wholly problems arising out of the necessity to make a number of little holes, made in a plate by one man at one time and one place, fit a number of little holes made by another man at another time and another place. When the holes are left out of the material, all parts fit, and the creeping and kindred problems so perplexing to the shipbuilder disappear.

The primary test of the completed hull will consist of filling with water and shifting the points of support. This will be carried out under continual and close scrutiny, and as one-quarter of the whole will be riveted there will always be a gage of comparison between the two systems of construction. The two systems will also be tested by subjecting each to bumping with rams and in various other ways, so that as far as is possible, apart from the conclusive tests of actual sea service, everything will be done in order to enable the shipbuilding authorities to form an opinion as to the relative advantages and disadvantages of welding as compared with riveting.

Structural Steel Standardized Cargo Vessels

How Quantity Production Was Met—Use of Structural Steel Expedient—Layout of Yard

BY HENRY R. SUTPHEN*

THE war brought about a new type of ship construction, commonly referred to as "fabricated ships," which only in part describes the new method that we have had to solve in manufacturing structural steel cargo vessels at the Newark Bay shipyard.

Our problem was one of quantity production, thereby necessitating thorough standardization of design, ship material, fabrication and assembly.

By referring to the newspapers during the months of March and April, 1917, before and after we entered the war, one will note with interest how much discussion there was over the problem of new ship construction made absolutely imperative by our entrance into the great world war. Some suggested large numbers of small wooden ships of 1,600 tons burden, with high speed. Others demanded larger ships, and many agreed that wood was the only material available to construct the emergency fleet.

In the fall of 1916 the Submarine Boat Corporation had completed for the British Admiralty 550 submarine chasers which were built of wood, the hull material having been fabricated in its Bayonne, N. J., shops and assembled into the finished boats at Montreal and Quebec, Canada. This was the first large boat manufacturing project ever attempted and was successfully completed ahead of contract time; it was the "model experiment" for the far greater task we are now engaged in of furnishing to the United State Shipping Board Emergency Fleet Corporation one hundred and fifty 5,000-ton steel cargo ships.

Why Structural Steel Was Made

Our experience in obtaining the proper quality of material for wooden boat construction, an art that had practically disappeared, made us feel certain that the large tonnage desired in wooden ships would be most difficult to obtain, not only on account of material, but also because of the shortage in wooden shipbuilding labor. Further, while wood could be fabricated into boat material, nevertheless the material would not stay put like steel, due to shrinkage, checking and rot.

Upon investigation we learned that the output of ship steel for months to come had already been allotted to the established shipyards for merchant work then under way and for naval requirements. We therefore recommended to the United States Shipping Board Emergency Fleet Corporation in April, 1917, that in place of wood we be permitted to submit a plan for manufacturing steel ships to be built with the ordinary commercial structural steel as had been employed in building our skyscrapers, bridges and tanks from which America had obtained such a reputation in steel construction; and, on account of the great emergency and the demand for a large number of ships, we further suggested that we be permitted to manufacture ships and not build them one at a time.

Our plan called for utilizing the large number of bridge and structural steel shops throughout the country which were not then busy with commercial work and which could be employed in fabricating steel shapes and plates from accurate drawings and patterns which we would supply. On account of using unclassified steel, we suggested that we compete in size of ship with the then proposed wooden vessel of 3,500 tons deadweight capacity, but as we progressed in the details of design and construction it was found possible to increase the deadweight capacity and still retain standardization in design and material to 5,000 tons, which is the size of the ship we are now producing in quantity. This size was fixed for other reasons. An analysis of pre-war merchant shipping disclosed the fact that the average commercial cargo carrier ranged between 4,000 and 5,000 tons with a full load speed of 9 knots. It was therefore believed that a 5,000-ton craft, able to make 10½ knots per hour, would be preferable and probably prove a desirable type for service in the years to come. Further, and of no less importance, careful investigation showed that the unit features of a 5,000-ton ship, fabricated at more or less distant outlying plants, would utilize freight car capacities to their fullest and most economical extent and still carry out the plan of having as many rivets as possible driven at the fabricating shops. A total of 427,000 rivets is required to be driven for one of these hulls, and of this total over 100,000 are driven at the fabricating plants, where the work is done on a much more economical basis than in the shipyard. For illustration, the smokestacks were so designed that their maximum diameter came within the width of an ordinary gondola car, permitting the stacks to be shipped completely assembled. The floors with intercostals were assembled in groups of three, the ordinary 36-foot flat or gondola car carrying six sets of floors, which, when loaded, kept within the railway clearance. It was recognized at the start that the railroads would be heavily burdened, and, as a very wide region would have to be drawn upon to furnish material, it was absolutely essential that the car space should be made the most of, so that the fewest possible carriers would be needed to maintain a steady flow of supplies to the assembly yard on Newark Bay.

Eliminating Curves in the Design

Our problem was first to use commercial structural shapes and plates that could be had in large quantities, and design the ships so that these could be assembled with a minimum of alteration through bending, and, next, that the plans should be so developed that the bridge builder and the structural shops should have no difficulty in reading the drawings and adapting their experience and equipment to the fabrication of the parts for ship construction. The naval architect had to speak and draw in terms familiar to the great army of structural steel workers, requiring some radical modifications in the matter of classification details, and imposing rather pronounced departures from the ordinary shipshaped models, in order that the materials at hand might be incorporated in the most efficient manner for maximum production and accuracy of fit. In brief, this necessitated the elimination of curves and the substitution of straight lines and angles wherever possible.

The decks are without camber and generally without sheer, the sides throughout the length of the parallel body are perpendicular; the bottom is flat and is merged with the sides by a short and abrupt curved bilge. By eliminat-

* Vice-president Submarine Boat Corporation.

ing the deadrise characteristics of the vessels it was possible to adopt a uniform size of floor throughout the parallel body and to have recourse to longitudinals which would all be of the same height. Forward and aft of the parallel body the model subscribes with reasonable closeness to that of the accepted design of ocean-going carriers.

As quantity production was the keynote in building these ships, it was essential that the main propelling machinery should be of types capable of being manufactured in quantity. Therefore, watertube boilers were chosen with reduction gear turbines. The boilers are of the Babcock & Wilcox make with a total heating surface of 5,800 square feet, operated with coal or fuel oil under natural draft. The propelling machinery consists of a geared Westinghouse turbine capable of developing 1,500 shaft horsepower, turning a 15½-foot, 4-bladed screw at 90 revolutions per minute. The turbine is connected to the propeller shaft by a helical, double reduction gear with a ratio of speed reduction of 40 to 1. The steam consumption of the turbine when operating at full power should not exceed 12.5 pounds per shaft horsepower.

The storage capacity for fuel oil is 660 tons, carried in the double bottom, which will be sufficient to operate the vessel 7,000 miles.

The ships are fully equipped with all necessary auxiliaries and deck machinery, with comfortable quarters for a crew of 60 men, including 22 men for military operations. Like all other ships building for the Emergency Fleet Corporation, the equipment is complete in every detail.

Commercial Shapes Used Advantageously

Referring to the fabrication and assembly of these ships, which undoubtedly is of the greatest interest to our members, the total weight of structural steel required for one of these ships is 1,564 tons, 462 tons being in shapes and 1,102 tons in plates. The only ship sections used in the design were a few bulb angles at both ends, amounting to 1½ percent of the total weight, or 23 tons. Under our contract all drawings were to be approved by both the American Bureau of Shipping and Lloyd's Register. This meant that, wherever in any particular the rules of the two societies differed, we had to adopt the more stringent rule, and this resulted in a heavier ship than would have obtained by classification in one society. Notwithstanding the increase in weight between these ships and those built with ship classification steel, it has been demonstrated that commercial structural shapes were used advantageously and did greatly relieve the steel mills from furnishing classification ship material.

Getting Out the Detail Drawings

Ninety-six percent of the total weight of the hull was fabricated at outlying establishments. Twenty-eight steel mills supplied material to 56 fabricating plants, not to mention the contributive labors of 200 foundries, machine, pipe, joiner and equipment shops which figure more or less in the building of a cargo carrier. The fabricating shops are scattered from Wisconsin to Massachusetts and as far south as Virginia, and, inasmuch as the parts are fabricated in such a large number of different shops and as the individual parts must be interchangeable, one of the first considerations was to make necessary provision for giving the information to the fabricating shops in such a manner as to insure accuracy of work and speed of production.

It was the bridge engineer working in conjunction with the naval architect who properly interpreted the details of ship fabrication into the language of the bridge shops, thereby permitting the structural shops to fabricate the complicated ship material with the tools and facilities they had in hand, an operation that many old-line shipbuilders question could be carried out successfully. So far as the straight parts of the parallel middle body, flat tank tops and flat decks were concerned it was an easy matter. It was simply a case of making detail drawings exactly as they would be made for a railroad bridge, giving definite location by dimension of every hole ,rivet and each piece of steel. In all some 330 drawings were made of details of hull fabrication. From these drawings all the steel was ordered from the mills exactly to the length required. In the molded portion of the ship, however, the problem became more complicated to the bridge engineer, as this section of the shell could not be mathematically developed. Such plates and shapes were developed full size on the mold loft floor, reproduced on template paper, having all rivet holes punched in them on proper gage lines and for a matter of record carefully measured up and detailed to dimension on individual drawings. Even with complete drawings it was difficult for the fabricating shops to reproduce the plates on account of the edges and gage lines being curved. These lines could only be located by dimensioning a series of points on the curves.

Overcoming Some Minor Difficulties

As we could not count upon two men springing a batten and getting the same shape between points, we overcame this phase of the problem by sending templates of the shell plates in the molded sections to the fabricating companies. These templates, made on template paper approximately 1/32-inch thick, were direct copies of the original template developed on the mold loft floor. A difficulty was experienced in the shrinkage and expansion of these templates, and, to insure the change of shape of the templates causing no misfits, each template was marked before being sent out with certain dimensions. To begin with, the paper used is fairly heavy fabroid material, which has a rather low coefficient of expansion. It was then marked and cut in accordance with the development on the scriveboard, and rivet holes, etc., were laid out upon the paper, spaced and dimensioned with great accuracy.

Checking Templates Against Drawings

The correct dimension for the length of the template, also the correct dimension for width at each end, was painted on with arrows indicating exactly where these dimensions were taken. In addition to this, a straight line was scratched the full length of the template approximately at the centerline. The shop receiving this template was requested, in all cases before using it, to measure it and make certain that the template, as they used it, was correct to the check dimensions given. They were also requested to test the straight line scratched on the template with a straight edge. When, as was very frequently the case, they found that the dimensions did not check or that the line was not straight, they were required to bring it to shape either by dampening it or drying it, as the case might be. There still remained, of course, the possibility that when a template had been expanded by dampening and stretching, the expansion might have taken place all at one section of the plate rather than throughout its length. As it was possible for this to happen, neither checking the dimensions on the template nor checking the straight line would detect the error. To overcome this we insisted that the fabricators check their templates against the detailed drawings which were furnished them. Inasmuch as the local steel tapes determined the measure of

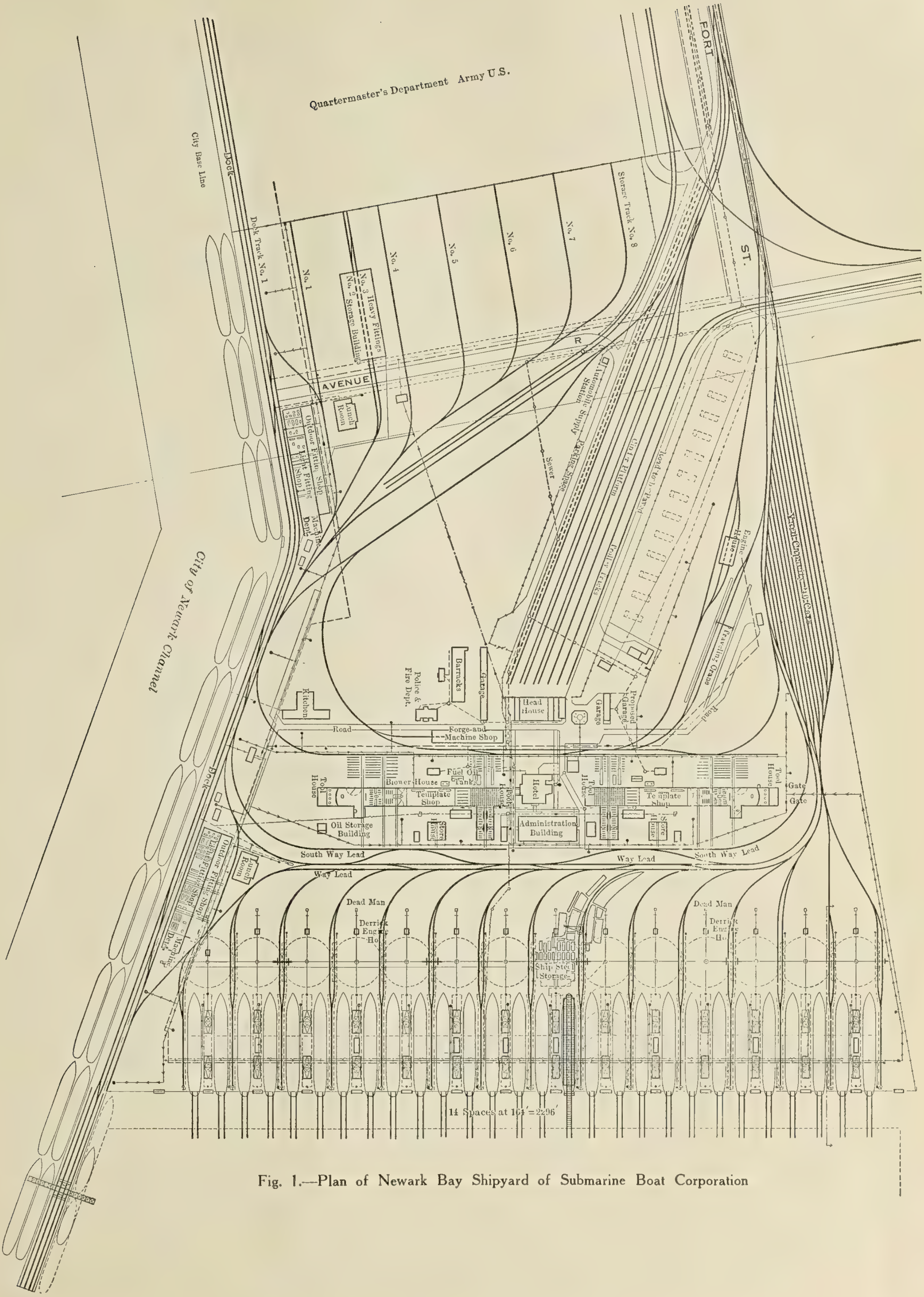


Fig. 1.—Plan of Newark Bay Shipyard of Submarine Boat Corporation

this variation, it was of prime importance that every tape at each and all of the outside works should be uniform.

A single tape was selected for the Newark Bay shipyard where the original templates and drawings were laid down on the mold loft floor, and with this master tape every other tape to be used was compared and carefully calibrated, and a coefficient, plus or minus, prescribed in each case. In this way it has been entirely practicable to insure dimensional agreement not only within the different departments of the Newark Bay shipyard, but similarly within the different departments of every outlying contributive establishment.

This seemed a large amount of checking, but it must be remembered that in each case this had to be done only once, as the majority of shops, after getting their template exactly as required, used it to lay out one steel plate or section which was used as a template for all duplicate operations. A tolerance of 1/16 inch was allowed on all punching, this being the amount of reaming that is done when the material is being erected.

Structural Workers Drive Tight Rivets

Not only is the hull material all fabricated outside, but also the material for machinery installation, such as piping, valves and innumerable fittings. The piping comes bent, with flanges attached, to exact shape, requiring only assembly in the ships. All joiner work and wood sheathing is fabricated in a shop at Detroit, Mich., and shipped to the yard in complete ship sets, and, as it is received completely finished, painted, varnished, and with hardware attached, it is merely a matter of assembly when the ship is ready to receive it.

Before the work started, the idea of fabricating ships on such a large scale was further questioned, on the ground that the structural steel worker could not drive a tight rivet and that his work would not be satisfactory nor pass inspection. Quite the contrary has been the result, as the work has been entirely satisfactory, equal in every respect to work done in the established shipyards, although the question of labor has always been a most difficult problem and could only be obtained by a system of training which has been very thoroughly developed. Over a thousand skilled workmen a month are being turned out by our training department.

Success Due to Layout of Yard

Our success is in no small part due to the layout of the shipyard. As the plan view shows, there are twenty-eight building ways, occupying a waterfront space of substantially one-half mile. Electrically operated derricks, each having a maximum lifting capacity of three tons, are placed between alternate ways and arranged with a reach which will enable them to deal with the materials for a pair of ships. Eighteen miles of railway track insure a steady flow of steel and other material by the shortest possible routes to the points of incorporation in the ships when on the ways or at the fitting-out dock, the latter having a length of nearly one mile, where twenty-two vessels can be berthed at one time, served by a 400-ton gantry crane with a lifting capacity of fifty tons. By an overhead structure, electric and steam cranes serve for minor lifts and place on board the ships directly from adjacent storehouses the equipment and material with the least amount of handling.

Between each companion pair of building slips and beneath the tower derricks is located an administrative building for the superintendent and foreman in charge of the two ships. Within this structure is kept a complete set of plans and all other necessary data. With the exception of the rivet forges, which have their blowers operated electrically, all of the other power tools are driven by compressed air supplied from seven direct connected electrically operated compressor plants.

The fabricating plant at the shipyard is divided into two sections, the north and south shops, as shown on the plan, where bending floors are located, also punch shops, rolls and forges. The bending floors are fed from eight furnaces, all the curved sections fore and aft being bent on these floors. These shops fabricate 4 percent of the total weight of the hull. The plates to be rolled are shipped flat from the fabricators, punched and shaped to size, and rolled at the shipyard. As many as 175 tons of plates have been rolled in a single day. Furnace plates, of which there are only eighteen, requiring hot forgings, are pressed hot in hydraulic presses at outside fabricating shops and shipped to the yard in blank form, where they are punched and worked to size to correct metal templates.

Exclusive of the rolled plates, these shops with their limited equipment have delivered 460 tons of frame material per week, working night and day shifts, which, we believe, will compare most favorably with other shipyards.

Rivets and Men and Ships

Rivet driving being the barometer of production has gradually increased from 30,000 per day during July to about 75,000 a day for October, with an average drive of thirty-two rivets per gang hour. As the men become more experienced and accustomed to their task, we believe that a higher average hourly rate will be obtained.

For the last two months we have employed an average of about 12,000 men and have been assembling at the rate of six ships per month; 18,000 men will ultimately be required to fully man the yard, when a production of twelve ships per month may be expected.

We are a little over a year old in our enterprise, having broken ground on September 14, 1917, and during this period, through an unusually severe winter, we have completed the shipyard, delivered our first ship, the *Agawam*—classed A1 by both the American Bureau of Shipping and Lloyds, this being the first fabricated ship built of structural steel to be delivered—and launched in all fifteen ships, which conclusively proves the soundness of the fabricated construction and how this method which we have employed has been the only one that could have been followed in the emergency to build the bridge of ships to Pershing and victory.

The Largest Motor Boat

The largest and most powerful motorship yet produced anywhere was, in September, put through her speed trials on the Clyde. This is the twin-screw, Diesel-engined *Glenapp,* of 10,000 tons deadweight carrying capacity. The total engine power of 6,600 horsepower is developed in two sets of 8-cylinder, four-cycle engines furnished by the Burmeister & Wain (Diesel) Oil Engine Company, Glasgow. The vessel herself was built by Messrs. Barclay, Curle & Company, Whiteinch, who previously were associated with the Burmeister & Wain works, and were pioneers in Great Britain in the matter of motorships. All the engine room auxiliaries of the *Glenapp,* also all deck machinery, including the steering gear, are electrically driven, the power being generated by two auxiliary Diesel sets in the engine room. A small oil-fuel boiler supplies steam for heating and cooking systems and for fire-extinguishing purposes. The oil fuel is carried in the vessel's double bottom, the space generally occupied by side and cross coal bunkers being thus available for cargo.

The Steel Ship and Oxy-Acetylene Welding

Autogenous Welding Decreases Strength of Steel—Behavior Under Heat—Restorative Measures

BY J. F. SPRINGER*

THE present necessity to construct quickly a vast total of tonnage has doubtless been the chief thing that has brought the newer methods of welding so prominently to the attention of shipbuilders and the government. The oxy-acetylene process has been winning its way steadily for the past decade, particularly in connection with steel plates. I direct attention to steel cylinders used in the transportation of gases under pressure and to steel barrels employed as containers liable to rough handling. The welding work here is analogous to that required in a ship's side.

However, not all operators of the torch understand what happens to the steel and what are the possibilities of restoring any damage to the quality incident upon the application of gas and electric welding. A good many are probably ignorant that there is any damage to quality that needs rectification. Let us then consider this matter.

Behavior of Steel When Heated

All normal, unhardened steel consists of crystals or grains built up of alternate laminations of cementite (Fe_3C) and iron, with or without separating films either of iron or of cementite. In steels containing less than 0.85 or 0.90 percent of carbon—such as are practically all steels used for ship plates—there is a honeycomb of pure iron. The spaces or cells in the honeycomb are occupied by crystals, or grains of interleaved layers of iron and cementite. Steels containing a higher carbon percentage—tool steels—have a honeycomb of cementite; the crystals are the same as before. For steel at the dividing percentage, there is no honeycomb; the crystals are the same, but they are now in actual contact. The interleaved layers of pure iron and cementite constitute a material (it is not a chemical combination, being non-homogeneous) which has been named *pearlite* by Professor Henry M. Howe, of Columbia University. For ship construction, steel having the first type of structure—a honeycomb of pure iron filled with pearlite crystals—is used.

Behavior of Crystals During Heating

The importance of this information in connection with oxy-acetylene welding centers on the behavior of the crystals of pearlite during a rise of temperature. As the temperature rises from the normal, everyday point, nothing of importance occurs until the steel has passed above a black heat. About *medium cherry red* (1,274 degrees F.), the grains begin to grow. As the temperature goes on up, the grain size continues to increase. Probably there is no substantial cessation of growth until the steel is at or near the melting point. If the heating is halted at any point of temperature, the growth will also halt. When the steel is cooled, whether suddenly or slowly, the enlarged grain size will still persist. Now all of this is not merely something interesting, but important practically, for the reason that cold steel with big grains is steel in an inferior condition. Its tensile strength is less than normal. Further, we are to accept it as a fact that the bigger the grains the weaker the steel. As cooling off does not restore the normal, small size and high strength, it will be readily understood why oxy-acetylene welding and similar processes (inclusive of blacksmith welding) necessarily injure the steel. These processes must use high temperatures. It is not in the gas processes, merely, that the working flame is at a very high temperature; the work itself becomes highly heated, the temperature ranging from at or near the melting point to lower temperatures as one recedes from the beveled edges and away from the groove. In the groove, every particle of the new metal has been actually melted. Of course, there has been great enlargement of the grain size. The metal must be regarded as greatly inferior in strength to the same metal when in normal condition. This applies to the new metal in the groove, to the sides of the groove and to the metal back from the groove. Every spot where the temperature has risen above medium cherry red must be viewed as damaged in strength.

Protection Against Oxidation

This is not a question of the burnt metal. Burnt steel is afflicted with a different disease. When steel is actually burnt, the carbon has been consumed. It is the procedure of burning steel that is employed in cutting with a high pressure oxygen jet. By this process an oxy-acetylene or other heating jet is used to heat up the metal and the oxygen jet follows it very closely. The oxygen attacks the carbon and burns it. The welding operation with the oxy-acetylene flame may, however, be very well protected against oxidation. Considering the fact that oxidation might result from the oxygen passing through the torch, a proper adjustment of the flame to a neutral condition should cover the matter pretty fairly. Nevertheless, it is quite customary with many welders to use some very pure iron for the new metal. As this iron contains little or no carbon, it is but little subject to burning. In so far as oxidation from the atmosphere is concerned, the torch may generally be managed so as to utilize the large flame, which envelops the little working flame, as a protection. It is, from its very nature, a reducing flame and consequently adapted to this purpose.

Account of a Curative Procedure

In seeking to use the oxy-acetylene procedure in welding ships' plates, it is probable that a damage from oxidation could be provided against with a good deal of success by methods such as those just indicated. With this damage eliminated, however, we would still have the deterioration attendant upon the enlargement of the grain size. If the welding of ships' seams is to be a success, this deterioration must either be cured or offset. Piling up the new metal is a method of offsetting. I now proceed to give some account of a curative procedure.

If steel that has had its grains enlarged by overheating be cooled off to any point distinctly below *medium cherry red* (1,274 degrees F.) and then reheated, its grains will begin to break up and assume a smaller size at a point of temperature at or a trifle above medium cherry red. This is understood to be a pretty well ascertained scientific fact. If the steel contains about 0.85 or 0.90 percent of carbon and, consequently, no honeycomb either of pure iron or of

* Author of "Oxy-Acetylene Torch Practice."

cementite, then this method is understood to yield very perfect results. Indeed, down to 0.50 or 0.40 percent carbon steel, the method is to be regarded as quite good indeed. The stopping point on reheating, however, rises somewhat above medium cherry red. Below 0.40 percent carbon steel the method is less perfect, because a compromise has to be made between carrying the heat up a bit and having a resizing of the grains that is less than complete. There is, then, a known procedure for the restoration of the quality of the steel. This method, as indicated, requires that the work be reheated after the welding is completed.

A second curative procedure may be mentioned, though it is perhaps not so successful in the generality of cases. It has long been known that working steel under the blacksmith's hammer has a beneficial effect. It did not require the new developments in connection with the microscopic study of steel to reveal this broad fact. What has been uncovered of late years is a more precise knowledge of the proper "stopping points." Probably, steel that is going to be *thoroughly* worked may be subjected to working at pretty high temperatures, provided the "stopping point" is well chosen and the working is continuous from start to finish. The grain size will then be somewhat larger than that which corresponds to the stopping temperature. In short, the hammer or other device will break up the grains; but the prevailing temperature is also getting in its work.

Professor Bradley Stoughton Quoted

Oxy-acetylene welders have sought to get the benefit of working by using the hammer on the weld. Probably it does some good, provided the hammering is not continued until too cool a point is reached. Let me quote from Professor Bradley Stoughton.*

"Mechanical work will multiply the strength of steel from two to five times. In order to accomplish as much as this latter, however, it is necessary (1) to reduce the material to very small sizes, in order that the beneficial effect of the kneading action may extend throughout the mass, and (2) to finish the work cold, in order that the metal may have no opportunity to re-crystallize. The ductility also will be increased at first by working, but again decreases if the metal is worked cold. The increase in strength and ductility is due (1) to decreasing the size of the crystals and closing the grain of the steel; .... (3) to increasing the cohesion and adhesion of the crystals. All these effects increase the specific gravity and hardness of the metal, and are more effective in these respects, as well as in increasing strength, if hot work is followed by cold work."

Restoration of Lost Strength

It is doubtful whether in the oxy-acetylene process full compliance can ever be given to the above requirement for a thorough kneading throughout the mass. Consider a longitudinal seam between two plates in a ship's side. Since the plates have been rolled in the process of manufacture, their normal strength presumably includes a decided advance on the strength of unworked steel. In fact, the high strength of the rolled plate was undoubtedly figured on in designing the ship. The process of autogenous welding materially decreases this strength because it undoes about everything that the rolling had previously accomplished. We seek to restore the lost strength by the use of the hammer. It would seem to be difficult, if not impossible, to reproduce with the hammer the condition which the rolling mill originally produced. Still, many difficult problems have been solved—this may be the next. Some mechanical device may be devised to work the metal in and along the seam to an extent equivalent to that accomplished with the rolling mill—some device which will secure penetration of its effects and will cover all regions involved in the high heat. Such an advance in the development of the oxy-acetylene process would not be anything very radical, since machine welding and cutting have both been done for quite a number of years. Wherever a machine can be used either for welding or cutting, better work can probably be done, as mechanical methods automatically secure evenness and regularity. Long straight seams, such as those on a ship's side, are particularly well suited to machine welding methods. It would seem, then, that a machine forger or kneader might very well handle this same class of work. Several years ago the present writer gave an account of European machines for the welding up of plate steel to form tubes. This process is very similar to the welding of ship plates. But I do not know of any machine which is especially adapted to work the steel after the welding operation.

One trouble with the hammer is the lack of penetration. "A blow creates in a metal practically nothing but compressive strains, which act chiefly in the vertical direction, and, by transmission, in the two horizontal directions. Because the pressure is relieved almost as soon as felt, the elasticity of the metal causes it to recover somewhat from the effect. This makes the effect of hammering superficial. Also the amount of yield to it is not great in proportion to its force, and therefore it takes more pressure to accomplish a result than would be the case if the application were slower. This makes hammering a slow process of reduction, but results in a better and more uniform working of the crystals on the surface at least, which is one of the chief reasons for the superiority of hammered over rolled material. Another reason, perhaps even more potent, is the exact control of the operation which can be exercised by the expert forger, especially his control over the temperature at which the work is finished, and over the varying forces of pressure applied at different stages and temperatures. On the other hand, the effect of forging extends only skin-deep from the upper and lower surfaces."*

Cold Drawing to Improve Strength

Perhaps a mechanical device could be produced which would exert an action superior to that of the hammer and more like that of the rolls in a rolling mill. It is quite probable, too, that the requirement mentioned in the preceding excerpt, which calls for cold working, can be more adequately and safely met by mechanical means. This is especially true if semi-skilled labor is employed. With a machine the regulation may be exact and uniform, insuring continuous movement of the steel particles, although small for any one moment. For example, cold drawing would be a very effective means of improving the strength of the material. Tremendous pressure, however, would have to be exerted in this process.

It will be easily gathered from the foregoing that the simple hammering indulged in by a lot of oxy-acetylene welders can be counted on but slightly. In the hands of a skilled welder who understands the thing at which he is aiming and the way to get it best with such a tool, the hammer is doubtless a good thing and the work will probably be the better for it. This is saying less, however, than that a full restoration can be thus accomplished or even approximated. In the hands of an ordinary oxy-

* Metallurgy of Iron and Steel," by Professor Bradley Stoughton, 1911, pp. 172 and 174.

acetylene welder, the hammer's usefulness would appear to be greatly limited.

After all is said and done, the re-heating method appears to be the better thing. It is all-penetrating, seeking out the regions adjacent to the weld and also regions inside the mass. It is not, or at least need not be, superficial in its action thus surpassing the hammer. Furthermore, heat is easily applied. In the first place, we have as a convenient source of heat the enveloping flame which surrounds the little white working flame. The temperature of this flame is not excessive—like that of the white flame—besides, it is safe, because of its character as a reducing agent. It has a great appetite for oxygen, so that it may be depended upon not only not to bring oxygen to the heated metal, but even to protect it from outside oxygen. Oxy-acetylene welders have been using this enveloping flame as a means of treating the weld, but that they have generally done so intelligently I am not prepared to vouch. The re-heating process, as has already been explained, gets its restorative results by heating up from a temperature point below *medium cherry red* (1,274 degrees F.). This is to be regarded as essential. It is not enough simply to wave the big enveloping flame over the newly welded work. Attention must be directed to starting the heat from a sufficiently low point—a cooling off must be accomplished first of all. It does not matter how cold the work is allowed to get. It may be a black heat or it may be stone cold. The point is to get it below 1,274 degrees. Naturally, in this re-heating procedure it is cheaper to heat up from a black heat than from a stone cold condition.

Action of the Enveloping Flame

But this re-heating does not have to be done with the big enveloping flame. This flame is a good one, especially since it has a reducing quality; but it is quite expensive, particularly in the present case. Sometimes there are uses for the enveloping flame which are advantageous and economical. This flame may at times be so managed as to provide a means of pre-heating without interfering with the simultaneous employment of the white working flame. When this can be done, the enveloping flame heats the work up through the early stages, thus relieving the white flame to this extent. To put this idea into use on steel plates in a ship's side, the torch might be controlled in a frame or bracket in such a way as to compel half of the enveloping flame to lie along the seam *ahead* of the white flame. The Edison Storage Battery Company has so used the oxy-acetylene torch in welding the vertical seam in the sheet steel containers which constitute part of a storage battery cell. The torch is held at a fixed angle by a holding device. The work is held in a clamp which carries it beneath the flame. The clamp is of such form as to divide the enveloping flame into two streamers, one lying along the seam ahead and one lying along the seam to the rear. Naturally, with the work fixed as in a ship's hull, it would be necessary to move the torch. The workman may do this or it may be done with a device adapted for shifting along the seam. This arrangement is calculated to quicken the welding operation, thus saving the time of the workman and reducing the expense for oxygen and acetylene. It is to be distinctly noted, however, that it does not provide for the restoration of the grain size of the steel.

To deal with the grain size, there must be an interruption. After the welding operation, the weld and adjacent work must cool, at least to, say, black heat before the re-heating begins. Consequently, the enveloping flame could not always be used simultaneously with the working flame, the latter doing the welding and the former doing the restorative work. There are, however, less expensive flames to use for re-heating—city gas or natural gas. That they shall act with great power is not so necessary as that they will not project products of combustion of a harmful character onto the metal. This point covered, almost any form of fuel will do that is reasonably manageable and capable of producing enough heat to bring the seam and adjacent regions up to temperatures ranging from full cherry red to, say, orange.

Objection to Refined Iron

It has been customary among oxy-acetylene welders working on steel to use some pure form of iron for the new metal to be put into the groove—Norwegian and Swedish iron and one or two American brands of refined iron. The idea seems to have been to prevent burning by supplying little or no carbon. The new metal is ordinarily in the form of a rod. Naturally, in moving this rod about it is liable to be exposed to the air. If it contained much carbon, the ordinary workman would probably be burning the hot end continually. Besides, the use of refined iron is at best only a partial remedy against carbonization, since the adjacent work may still be affected. Furthermore, it does not deal at all with the condition resulting from big grains.

A second objection to the use of refined iron for the restoration of the quality of the steel when re-heating concerns the matter of the normal strength of the material prior to any deterioration from any source. It is well known that iron is by no means as strong as steel. Only a comparatively few people know, however, that the tensile strength of steel is strictly proportional to its carbon content. This rule covers at least all steels below tool steels. Each small addition to the carbon percentage means a considerable addition to the strength.

H. H. Campbell gives, in effect, the following rule: Beginning with steel of a zero carbon content—40,000 pounds per square inch of cross-section is assumed as the ultimate tensile strength of basic or open-hearth metal—for each 0.01 percent added to the carbon content, 1,000 pounds is to be added to the initial valuation of the strength at 40,000 pounds.

It may be gathered from the foregoing that pure iron is hardly in the same class with steel. A weld made of pure iron will probably consist of material weaker than the adjacent steel plates, if the latter are of first quality, even if no deterioration of the iron occurred in the welding process.

Another Objection and Summary

I have also further objections to make to this custom. From information about iron and steel which has been developed during recent years, it is understood that the re-heating process is quite successful with steels containing between 0.50 and 0.90 percent of carbon, but less so with steels containing smaller percentages.

To sum up, the oxy-acetylene process can probably be employed with success in marine work, not only in connection with ordinary miscellaneous jobs, but with work of welding the joints in the hulls of steel ships. But—and note this "but"—if only the ordinary procedures are employed, the tensile strength of the material at and near the weld is to be reckoned as decidedly less than that of the plates. Restorative measures are possible, but they must be applied intelligently and adequately.

Selling a product below cost just to keep some other maker from getting the job is not business. Business is making money.

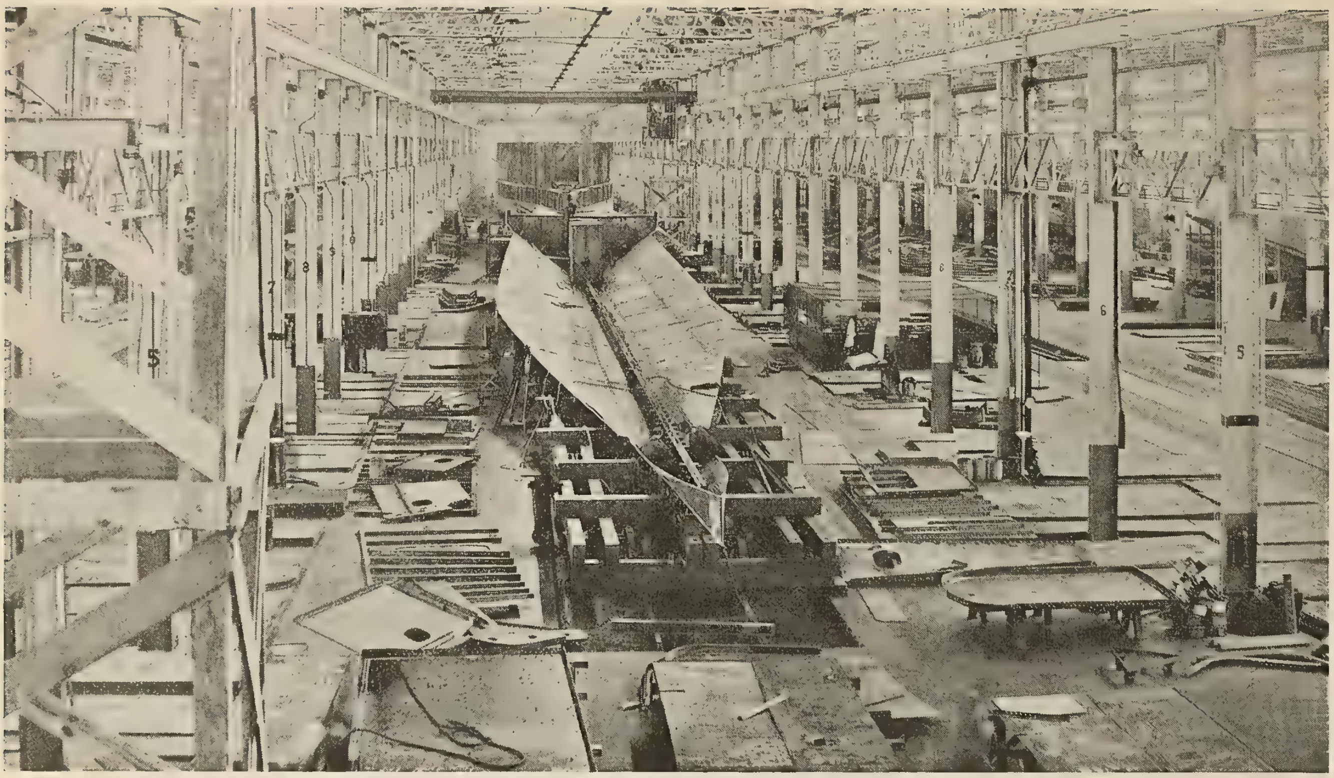


Fig. 1.—Station Where Keel, Bottom Plating and Bulkheads of Ford "Eagles" are Erected

Building the Ford Submarine-Chaser "Eagle"*

A Straight-Line Design—The Two Parts of the System—Hurried Development of the Process

In its completed form, as it now exists, the "Eagle" manufacturing system comprises the following elements: (1) A factory design of ship, prepared in its entirety by the Navy Department, a design which has straight lines substituted for curves as far as possible, in longitudinal lines as well as in cross-section, and with the utmost simplicity and strength of structure; (2) multiple punching applied as extensively as possible; (3) pre-assembly or sub-assembly of parts that can be set in place as units; (4) erection of the ships in a long file moving forward to the material and to the workmen; (5) lateral short-distance movement of the hull materials from the storage piles to the ships; (6) step-by-step movement, the file advancing one station (the length of one hull) at fixed intervals (three to six days); (7) arrangement of the work in three parallel competitive working lines; (8) railway-truck mounting of the hulls during erection; (9) transfer of the completed hulls into the water by a hydraulic elevator; (10) installation of interior fittings, machinery and other parts in step-by-step progressive movement of the ships along the fitting-out dock, by a series of stations like those of the hull erection, and with short-distance lateral movement of the material.

The two parts of the system—hull assembly and fitting out—together constitute a straight-line progressive ship-building mechanism, but are physically separated by the launching platform at the center of the plant. A straight-line plant arrangement serves for carrying out the straight-line process.

It does not appear that any one of these elements is vital to the success of the fundamental task of building the ships rapidly. However, taken together they to-day constitute an integral mechanism—the "Eagle" production system—and they are so interrelated that each one is essential to the successful working of that mechanism. This mechanism grew together gradually during the evolution of the enterprise; its elements did not come into being as parts of one original conception.

The ship design itself underwent some change during the working out of the manufacturing procedure. Thus, originally the side frames were 6-inch heavy flanged channels, but when it was recognized that these might give trouble in beveling (required in the stern and bow sections) they were changed to flanged plates, following the design already adopted for the floors and brackets. Furthermore, the straking was changed so as to make as many as possible of the side and bottom plates parallel-sided and rectangular, to permit of the greatest possible extent of multiple punching. Some other changes of minor character were made in the design. The important development and change, however, were in the manufacturing system. Essential help in working out both the system and the design was obtained through the construction of a pattern ship in the Ford automobile works, even before the ship plant had begun to take shape.

Following Ford Assembling System

Taking the work to the material and men, the idea of the Ford automobile assembling system, was at first intended to be applied by a conveyor-like arrangement, the ship moving along continuously at very slow speed.

* Abstract through courtesy of *Engineering News-Record.*

Though the company was not experienced in shipbuilding, its successful development of automobile manufacture produced the conviction that the "Eagles" should be built under a roof and that the conveyor-assembly method was practicable and would result in great gain in time, cost and quality. In view of the novelty of its undertaking, the company did not call upon either naval architects or shipbuilders to plan the factory operations. Getting the new enterprise started was, under these circumstances, like building a machine of a wholly new kind and making it an operating success—which, incidentally, describes accurately the task of developing the turbine power plant with which the ship is equipped.

Time for leisurely and careful development of plans was lacking, under the urgent rush for earliest possible production. Prompt decisions and quick action were absolutely essential. The development, therefore, was a trying process to all concerned, and some steps were taken that conflicted with later decisions. For example, in order to get construction started, the buildings had to be designed before all phases of the manufacturing process were elaborated, and it was found afterward that somewhat different arrangements in this or that detail would have been better. That an efficient ship-producing machine was created under these conditions, and made ready for service in phenomenally short time, testifies to the value of the combination of able men concentrated on the work.

Continuous Movement Impracticable

In the development of the process, study based on shipbuilding experience early indicated that continuous movement of the file of ships was not practicable, as the individual operations in the hull assembly are necessarily slow and involve large quantities of material. Step-by-step movement took its place, the string of hulls to be shifted forward one ship's length at a time. Seven stations were decided upon; this number was not dictated by inherent requirements of the ship-assembly process, but rather by the anticipated rate of working and the space conditions at the site. The three separate assembly buildings were joined into one, with a material supply bay between and joining the assembly bays (line bays). Preassembly of parts then came to be recognized as an important agency of rapid working, and a length of about 200 feet was added at the incoming end of the assembly shop for doing this work. The progressive or step-by-step method was extended to the fitting out work, since this half of the manufacture involves as much labor as the hull construction and brings into action even a greater number of trades. Finally, after the shop was already in service, the order of assembly operations was fixed with regard to proper balance of time at the stations, as determined by actual experience in the shop. For fabricating the hull material, single punches were depended upon when the pattern ship was built. Later, machines were considered which would punch a group of holes at a time, the plate then to be shifted ahead by the length of a group. The example of bridge-shop practice prevailed, however, and multiple punching was adopted—using presses having a transverse gang of punches capable of being actuated simultaneously or in sets, and a rack for longitudinal spacing. The equipment plan of the punch shop was revised accordingly, after the building was under construction. Further development occurred later in balancing up the number of multiple punches and of single punches (for doing the work to which multiple punches were not adapted).

An important contributory factor in the success of the plant development lay in the large resources of the Ford Motor Company in machines and factory equipment. Thus the whole shop-crane installation of the River Rouge factory was brought together from Ford assembling plants all over the country, and the multiple punches which form the backbone of the fabricating end of the plant were fitted up from presses taken out of the sheet-metal department of the Highland Park automobile works.

General Description of Plant

Lying along the left bank of the widened and canalized River Rouge, some miles from Detroit, the plant extends

Fig. 2.—Table Upon Which Hulls Are Transported from Shops to Launching Platform

in a straight line downstream. Starting at the north end, its successive parts are the plate storage yard, the punch shop and, across a transverse road, the huge assembly shop which constitutes the main feature of the plant; just beyond this shop and a short distance to the right is the launching platform to which the hulls are moved by a transfer table. A few hundred feet downstream begins the concrete dock and ore storage space of the Ford blast-furnace plant. On this dock has been erected a long, narrow fitting-out shed, in two sections, each about 1,000 feet long, which hold the machinery and equipment for the finished hulls lying alongside the dock and moving forward in successive steps to receive different parts of the equipment. Supply warehouses nearby feed the fitting-out sheds.

Direct forward movement of material, in the least number of separate moves, characterizes the plant. From the storage yard, plates and shapes are moved into the punch shop partly by hand and partly by locomotive crane and cars. After the marking, punching and other fabrication, the material is loaded on short railway trucks moved by hand along one of four longitudinal tracks leading into and along the supply bays of the assembly shop. It goes directly to the place where it is to be assembled in the ship, and is unloaded and piled alongside that point. An exception is made in the case of material for pre-assembled parts, such as frames, deck sections, bulkheads and the like, which is unloaded at the head of the assembly shop and is bolted up and riveted there. The completed parts are then moved down the shop to the proper station by bridge cranes spanning the assembly bays.

Thus the material and supplies, having once reached the punch shop or the warehouses, undergo in general but a single move to a point directly adjacent to the place of assembly in the ship. From there a short cross-transfer only is required to put them in final position.

Largest Punch Shop in the World

Building up a working mechanism for carrying out this revolutionary process of ship construction was done with equal originality and disregard of precedent. Fully as impressive as the boldness of the designers, however, is the great size of the units of the plant. The punch shop in which material is fabricated ready for erection in the hulls is the largest shipyard punch shop in existence. The assembly shop contains twenty-one shipbuilding berths under one roof, and, in addition, a pre-assembly space. Indeed, the entire boat-building operations, stretching as they do in line a mile above the River Rouge, are covered by eighteen acres of buildings. The structures included are: A punch shop, an assembly shop, two fitting-out sheds, a transfer table, a launching bridge and several service buildings.

Primarily, the revolutionary shipbuilding methods are centered in the assembly shop. This shop represents the equivalent of twenty-one building berths, and in addition the finished material storage and the pre-assembly shop. It is the key feature of the River Rouge factory. All the hull erection work is carried on under its roof.

Description of Assembly Shop

The assembly shop is a steel frame structure 300 by 1,700 feet in plan, with clearance height of 36 feet 5 inches, except that the ship assembly bays have a clearance height of 50 feet 9 inches for 400 feet at the outgoing end. In spite of the great width of the building, excellent daylight is obtained throughout its area by ample glazing of sides and roof monitors.

Passing down the length of the building in three separate files, the hulls under construction occupy successively the seven stations indicated on the plan. Each file is separated from the next by a supply and material storage bay. All five bays are 51 feet wide. A narrower lean-to along each side supplements the supply bays. Bridge cranes span the assembly or working line bays. Each line bay is served by four 5-ton cranes, one of which is situated in the high part at the outgoing end. There are no bridge cranes in the supply bays, but instead several hand-trolley jib cranes are bracketed to the columns near the incoming end of the building.

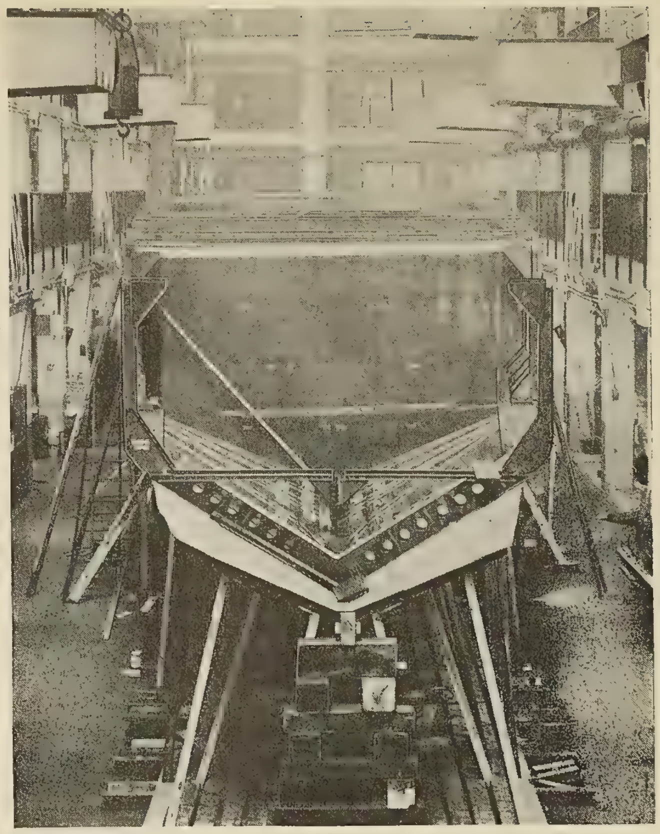


Fig. 3.—Pattern "Eagle" from Which Details Were Developed

By this arrangement, space is provided alongside each hull erection station for the material required at that station. Plates and other parts fabricated in the punch shop (at the right, a short distance from the incoming end of the assembly shop) move down the center of one of the supply bays on wheeled trucks running on a track the full length of the bay, and are unloaded directly at the station where required.

When the idea of erecting the hulls in a file of carriages moving along the railway track was conceived, the decision was also reached to use a standard gage track for this ship support because standard railway trucks could be used (with springs blocked). Though the wheelbase of 4 feet 8½ inches is narrow in comparison with the size of the ship, no trouble from lack of stability has been experienced. As the hulls grow, shoring is set against the bottom or the sides, either for temporary support of parts or to hold the ship securely in place. Aside from their wheel support, the trucks are secured against tipping by outrigger shoes attached to the truck bolsters and extending down to within ¼ inch of the rail of a track of 10-foot gage. This outer track is laid the full length of the working line bays, on the transfer table and on the launching platform.

The successive carriages of the assembly file are not connected as they would be under a continuous movement arrangement, but are moved individually when the file is

shifted ahead one station. The wedge keel blocks, a relatively late addition, provide for accurately level setting of the keel and any necessary readjustment. A hull carriage comprises eleven sections supported by twelve 4-wheeled trucks, but at stations 6 and 7 the two rear sections are taken out and the stern of the ship is supported by shoring from the track and platforms, to give room for placing the shaft bracket and boring the tail-shaft bearings. The weight of the hull at the time of launching is about 250 tons, of which 200 tons are structural material.

Organizing the Assembly Process

Organizing the assembly process was a matter of gradually learning by trial how much time the individual operations consume and how they can be allocated most advantageously to the different stations so as to suit the requirements of hull construction. A prominent factor in this development was the evolution of pre-assembly of parts. The large pre-assembly space at the incoming end of the building now has all its skids fully occupied with parts being bolted and riveted up. Riveting is done wholly by air hammers, although a horizontal gap riveter is provided in one of the bays.

Pre-assembly Key to Rapid Production

Pre-assembly of keel and keelson girder at station 1 constitutes a particularly interesting item of this preparatory work. It is done on horses immediately alongside the first station. When the file of hulls advances, and station 1 is vacated, a hull carriage is brought back from the launching platform (in separate truck sections) by the bridge cranes and is placed and assembled with its sills and bolsters. Then the finished keel is swung across to position on the keel blocks, ready for the setting of frames.

Until recently, frames, bulkheads, deck sections and tanks were the principal items pre-assembled. As it became increasingly clear that pre-assembly was the key to rapid station work, the subject was taken in hand more boldly. Now the complete stem section, about four frames long, and the stern for a length of about eight frames, are built complete on the skids and set in place as units. A great amount of handling, fitting and bolting is saved, which cuts down the building time and reduces the concentration of men. Furthermore, much riveting is transferred from the stations to the skids. About 15 percent of the rivets in the ship are driven in the pre-assembly.

One of the special devices developed for facilitating pre-assembly is a frame assembling gage. Here the separate floors, brackets and side members of a frame are set in proper position without any measuring or fitting, after the standards of the gage have been adjusted to the correct widths of the frame in question by a right-and-left screw in the base. Bolting up and riveting are then carried out quickly and with no uncertainty as to whether the correct shape of frame is obtained. This jig was designed by Superintendent Whiting of the assembly shop.

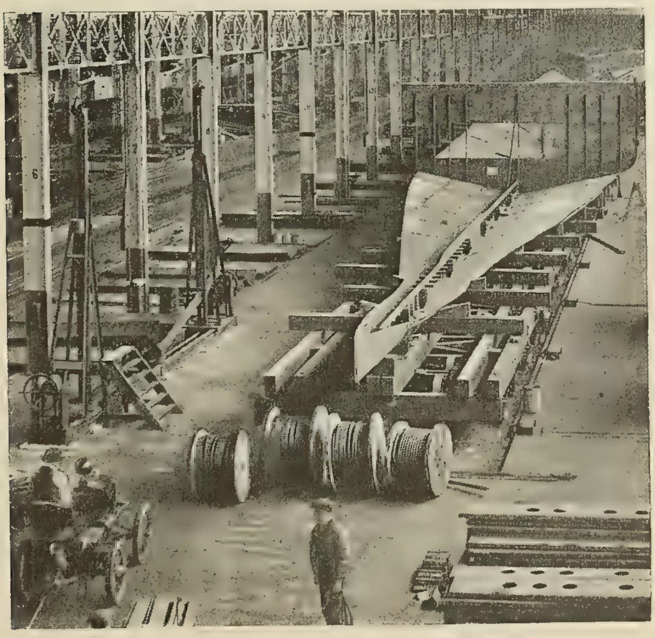


Fig. 4.—Special Gage to Facilitate Riveting

Organization of the Hull Assembly

Before the various operations involved in the hull erection could be scheduled as to order, and the items allocated to specific stations, many preliminary difficulties had to be overcome. With a new kind of ship and a new shipbuilding procedure the methods of doing some parts of the work had to be developed by actual trial in the shop. Every change in method—and sometimes detail changes in the construction of the ship—influenced other parts of the work as to best order and convenience. The time required for the several elementary operations could not be determined exactly at the start, and therefore an accurate balancing of the several allotments of labor and time to the stations was necessarily a matter of successive approximation.

One kind of difficulty is illustrated by the schedule for station 1. Originally the plan was to complete the entire main frame of the ship here, in order to produce a relatively stiff and robust hull structure before the first move. The early schedules were altered when experience on one or two hulls in the shop showed that this plan of complete frame erection consumed too much time for one station. Further, it was found that moving the carriage ahead on its track did not disturb the position of the parts perceptibly, even when the framing was not complete.

In the form finally adopted, the schedule of operations distributes the total work among the seven stations as nearly as possible in equal shares, except in so far as individual operations like that of boring the shaft bearings and subjecting the hull to hydrostatic test are locally governing factors to disturb the balance.

Side Keelsons and Stringers

At station 1, after the truck is made ready for the hull, the assembled keel is slid over from the assembly horses, the keel plate at the after end of this section is set, and then in successive order are placed the two bottom strakes, floors and bulkheads of the after end, the forward athwartship bulkhead, the assembled frames of the main portion of the ship's length, and the lower strake of the side plating. At station 2 the side keelsons and stringers are bolted up and the assembled boiler foundation and turbine foundation are placed; the bilge strake is set and a number of minor parts are added. Stanchions and platform deck beams are also set at this station.

Process of Riveting

Riveting begins at station 3 and continues throughout stations 4 and 5, being virtually completed before the ship goes to station 6. At station 3 the largest items of work are setting the unit assembly bow section and the corresponding stern section, finishing the main framing with stanchions and deck beams, setting the steering engine, and doing all the riveting below the platform deck.

(To be continued)

Naval Architects' Annual Meeting

Twenty-sixth General Meeting of the Society of Naval Architects and Marine Engineers—Abstracts of Papers Presented

The twenty-sixth general meeting of the Society of Naval Architects and Marine Engineers opened in Witherspoon Hall, Walnut and Juniper streets, Philadelphia, Pa., on Thursday morning, November 14, with Lieutenant-Commander Stevenson Taylor, U. S. N., president of the Society, in the chair. The first business taken up was the reading and approval of the annual report of the secretary-treasurer. The report showed the membership of the Society on November 1, 1918, to be 967, as against 875 a year ago. Five hundred new members were unanimously elected. According to the treasurer's report, the total resources of the Society amount to $38,714.59 and the total liabilities $3,547.21, making the Society's present worth on October 31, 1918, $35,167.38 (£7,403).

The following deaths were recorded during the year: Honorary associate, Right Honorable Lord Brassey, K. C. B.; life member, Edwin A. Stevens; members, George W. Dickie, Charles R. Hanscom, Robert Logan, George W. Magee, Ignatius E. Thayer, William H. Varney, John D. Van Buren; associates, Harry B. Bloomsburg, Frank S. Masten, Thomas S. Matthewson, Jacob W. Miller.

Opening the convention, Commander Taylor announced the election by the council of Rear Admiral Washington L. Capps, U. S. N., as president, and other officers as follow:

Honorary vice-presidents—Rear Admiral David W. Taylor and W. M. McFarland, of New York.

Vice-presidents—J. W. Powell, vice-president of the Bethlehem Steel Corporation, South Bethlehem, Pa.; Commander H. I. Cone, U. S. N.; Lewis Nixon, New Brunswick, N. J.; Cecil H. Peabody, of Boston; H. D. Goulder; W. J. Baxter, naval constructor, U. S. N.; H. A. Magoun, vice-president, New York Shipbuilding Corporation, Camden, N. J.; C. P. Weatherbee.

Council—W. D. Forbes, New London, Conn.; Spencer Miller, South Orange, N. J.; C. F. Bailey, Newport News, Va.; Robert Haig, Chester, Pa.; associates, E. M. Bull, of New York, and C. M. Wales, of New York.

Executive Committee—Commander Stevenson Taylor, Andrew Duncan, W. M. McFarland, F. L. DuBosque, and J. W. Powell.

The president of the Society then read his annual address, from which the following extracts are taken:

Abstract of President Taylor's Address

After reviewing the changes that twenty-five years, a quarter of a century—a generation—have brought to the Society; and then entering upon a review of American shipyard production and methods to date, President Taylor turns feelingly to the future, with an appeal on behalf of the merchant marine.

America's one great problem with the realization of peace, he points out, is, in effect, What was to be done with the merchant marine? Shall we as a nation supinely, as in the past, permit other nations to carry our entire commerce overseas? It is to the merchant marine that we must particularly attend, and now that the end of the war has come, the problems following the destruction and disorganization caused by the war demand the attention of our best ability and judgment. It is the one great problem for us to consider. Certainly it is incredible that any administration in the United States Government shall sacrifice the great funds and efforts individually and collectively that have been expended in the last two years to build up facilities, educate men, and women, too, in order that we may have and operate ships of our own. If there are laws upon our statute books that prevent our reasonable operation of ships, they must be amended.

And yet we may look to the future with optimism. We must neither think nor say that it cannot be done. It can be done, as we have so ably proven during the past year, he maintains, and then concludes: "We have performed gigantic tasks more rapidly in all the circumstances than could any other nation in the world. We shall build ships, we shall secure and train officers and sailors, and we shall establish and keep forever a merchant marine on the seas of the world; for the sea was in our fathers' blood, the ocean is our birthright."

Delamater Iron Works—Cradle of the Modern Navy

BY H. F. J. PORTER

ABSTRACT

In the late thirties of the last century, the author points out, a group of machinists, foundry men and expert mechanics who lived in what was then Greenwich Village, a suburb of old New York, joined forces and founded the Phœnix Foundry. Cunningham, Hall DeLamater (the elder), Hogg, Rider and Warden are the names associated with the venture. To this group of men was introduced John Ericsson, then a young, well-born Swedish engineer, who had developed plans for a steam frigate in which the United States Government was interested. Especially close was the intimacy of Ericsson and young DeLamater, then about twenty years of age, and rarely in later years did either take a step in the nature of a business venture without consulting the other.

In 1842, Ericsson was commissioned to do the engineering work of designing the engines and hull of the iron frigate *Princeton*. Ericsson at once placed the order for the engines and the propellers with the Phœnix Foundry, and the hull was constructed at the navy yard in Philadelphia. This was the first iron steamboat built in this country, and with its propeller wheels and engines wholly below the water line, presented a design which was at once adapted by this and all other countries for naval vessels of the future. In this beginning, which was later followed by further advances just as radical, these works should easily lay claim to being "the cradle of the modern navy."

In 1842 the fortunes of the Phœnix Foundry were continued under the name of Hogg & DeLamater, later known as the Hogg & DeLamater Iron Works. In 1858, the shop became known as The DeLamater Iron Works.

When the Civil War broke out, these large and well-equipped shops possessed special facilities for war work, and Mr. DeLamater promptly offered them to the Government for such work as might be needed. Knowing Ericsson's mental equipment in ordnance engineering science, Mr. DeLamater frequently consulted with him about the work they would be able to do for the Government. In the dire extremity of the country, Ericsson's plan for the *Monitor* was rushed to completion. The keel of the *Moni-*

tor was laid by Thomas F. Rowland at the Continental Iron Works, Greenpoint, Long Island, October 25. Steam was applied to the engines at the DeLamater Iron Works December 30. The men who actually operated the engines and boilers of the *Monitor* in the battle were from the DeLamater Iron Works.

Immediately, the works received orders to build six vessels of the same type, but of various sizes, some of them much larger than the *Monitor*. The war vessel was changed in one day. The Monitor type became the war vessel of the world. The hulls of these boats were constructed at the Brooklyn Navy Yard and private shipyards; the engines, propellers and other machinery were provided by the DeLamater Iron Works.

From this time on the works were known as the germinating place for new ideas—"the works became a veritable nursery in which inventors had their ideas developed." In 1869 the works built thirty gunboats for Spain as protection against Cuba. In the same year they built the *City of Merida*. In 1874 the *Dictator*, which had originally been built in the DeLamater Iron Works, a boat of the Monitor type—returned for speedy repairs to combat the Cuban scare. Captain Ericsson, who had been at work on harbor defense at this time, developed the *Destroyer*, which carried a submarine gun and discharged a compressed air projectile 30 feet long, loaded with 350 pounds of explosive. The DeLamater works built and launched it very successfully. Later, John Holland, a Roman Catholic priest, had his first submarine torpedo boat built there.

The development of this large works ceased with Mr. DeLamater's death in 1889. It was in the minds of most men a great calamity that Mr. DeLamater should have died when he did and that the works, which he built up and maintained with so much effort and at times with severe struggle, and which always took such a prominent part in the history of the nation, should have ended its career simultaneously.

Revival of Wooden Shipbuilding as a War Industry

BY CARLOS DE ZAFRA, M. E.

Abstract

This is an interesting paper, pointing out that the supremacy of nations has been ever proportional to their command of the seas. Greek history, Egyptian history, Roman and Spanish history, the author goes on, are each most exciting during their respective sea power periods. Little difference did it make were the propelling force man power, as exemplified in the 40- and 60-oared galleys of medieval days, or sail or steam, as of to-day. Dealing with the present era, steel seems to have been introduced as a shipbuilding material about 1870, but there is no denying that the wooden vessel had given excellent service, and in the emergency in which we recently found ourselves, and notwithstanding the tremendous steel output for shipbuilding purposes, the wooden ship, which gradually had become obsolete, was again brought into its own.

In connection with the present shipbuilding activities, the author continues, there has been considerable speculation as to what will be the amount of tonnage produced by the United States during the year 1918. A recent estimate places this amount at 4,000,000 tons deadweight capacity—even 6,000,000 tons have been mentioned in an offhand way. Stupendous events and undertakings are under way, and the expectations of the allied governments are such as demand tremendous results from us.

The sudden revival of wooden shipbuilding as a war industry necessitated a revival of old shipyards, their enlargement and modernization. It meant the return to shipbuilding of many who, through its decadence as an industry, had sought a livelihood in other directions. It caused the construction of new shipyards from new materials and under the guidance of new minds—and, strange as it may seem at first, some of the most successful of the new enterprises have been under the jurisdiction of the "landlubber," the constructor and the civil engineer.

To-day's problems have introduced some new details of construction. On the Pacific coast long timber is available, keel sticks being from 80 to 100 feet, and in a few instances, I am told, as long as 150 feet between scarphs, while on the Atlantic coast a 50-foot length would be considered a good specimen. On both coasts, however, steel has been introduced for keelsons and for brackets or braces to supplant the ever-decreasing supply of ships' knees.

The use of iron strapping on wooden vessels necessitates rabbeting the frames so that the frame and strapping surfaces will present a smooth face on which to lay the planking. To expedite this work, a portable pneumatic rabbeting tool has recently been developed and used with excellent results.

Painting by the old hand-and-brush method was laborious, time-consuming and ever wasteful. The use of compressed air has solved these difficulties to a great degree.

On the west coast we prided ourselves when a new keel was laid in twenty minutes after the launching. Later we beat it at sixteen minutes, later at eleven minutes, and finally got it down to one minute—a world's record. In the old days many weeks would elapse before a new set of keel blocks was ready and the new sticks were scarphed and ready for assembling and fastening. Now, thanks to the introduction of quantity production and fabrication methods to wooden ship production, we can use the same keel blocks without disturbing them at launching, and by having the new keel all in readiness under the bilges it can be hauled to place on the vacated keel blocks as rapidly as the sister ship glides to her maiden plunge.

Application of Buoyancy Boxes to the Steamship "Lucia" for the United States Shipping Board

BY W. T. DONNELLY

Abstract

The unprecedented sinking of vessels by submarines in the early part of 1917 directed universal attention to the possibility of protecting ships against the attacks of the submarine. The result was a tremendous influx of ideas—scientific, practical and impractical—to all the departments in Washington, and it soon became apparent that some organization must be gotten together to handle this mass of material and meet by counter endeavor, if possible, the menace of the submarine. This resulted in the creation, jointly, by the Naval Advisory Board and the United States Shipping Board, of the Ship Protection Committee. The preliminary work of the committee consisted of classifying and considering several thousand suggestions dealing with many real, and more imaginary, methods of overcoming the submarine.

The method of rendering a ship safe against sinking by internal buoyancy boxes was the outcome of the writer's experience in the construction of floating dry docks, and this experience has been embodied in a United States patent, dated April 17, 1917.

The idea first took shape before the committee in a copy of this patent submitted from the Patent Office by a clerk of that department.

The writer, on behalf of the committee, prepared preliminary plans and calculations and investigated the vessels available. This resulted in the selection of the former

Austrian steamship *Lucia* of the following general dimensions and tonnage: Length, 418 feet; beam, 54 feet; depth, 37 feet; gross register, 6,744 tons; net register, 4,386 tons; coal bunker capacity, 620 tons; water ballast, 1,583 tons; deadweight capacity all told, 9,600 tons; summer draft, 28 feet 11½ inches.

The *Lucia* was a modern steel freighter, built in Trieste, Austria, in 1912 and equipped with English machinery.

From the plan as outlined by the figures and drawings it appeared simple, but the carrying of it out for the first time under war conditions was found to be anything but a simple matter. The only material available immediately for creating the buoyancy boxes was ordinary lumber and galvanized iron, and the quantity of sheet metal required was rather a surprise to local markets.

It was soon found that ordinary methods of construction would not do, and careful experiments were necessary to develop the details of construction for the boxes as set forward in the plan.

After the type of box and entire construction for withstanding pressure had been developed, many difficulties were met with before absolutely watertight results could be obtained, and these results were finally maintained only by testing every box by air pressure and floated in a tank before placing it in the vessel. Approximately 12,000 boxes, divided equally between buoyancy boxes for ship, or cargo, were required.

From a strictly engineering point of view, to question the possibility of rendering a vessel unsinkable under ordinary conditions by such a method is beyond dispute. It is simply a question of the quantity and strength of the buoyancy boxes used. To question the carrying capacity of the ship when so fitted is to question the simplest form of mathematical statement which can be made.

Finally, in the general question of whether ships shall be made unsinkable at sea or not, the time required to so construct a ship will have no bearing whatever upon the problem. The writer is free to admit that military reasons may properly control any action, commercial or otherwise, during a time of war, but at the same time begs to state that only engineering and economic reasons will finally control the question of rendering ships and cargoes safe against loss at sea.

Discussion

After presenting his paper, Captain Donnelly read from another paper which he had prepared since the sinking of the steamship *Lucia*. This second paper set forth clearly that the sinking of the vessel was due to a shifting of her cargo, consisting of heavy trucks. These, it appeared, had pounded their way through the upper decks and into the hold, where the impact had set up stresses which eventually proved disastrous to the ship. Discussion was submitted from the auditorium to the effect that it probably would have been better if the government had turned its attention to methods of destruction of submarines absolutely, rather than to the subject at all of methods of saving torpedoed boats. Captain Donnelly rejoined that the saving of life and cargo was fully as necessary as was the destruction of that which made necessary the saving of life and cargo—submarines. There was nothing more said.

Notes on Progress in Turbine Ship Propulsion

BY FRANCIS HODGKINSON

Abstract

This paper sets forth, among other things, that it is common practice on shipboard to provide a closed or tubular heater to which is led the exhaust steam from the auxiliary machinery, which latter exhausts at a pressure between 5 and 10 pounds gage. The exhaust system is provided with a connection to let any proportion of this steam to the condenser. Sometimes again there is a hand valve, permitting any surplus of this steam to be taken to a low pressure stage of the turbine, all of which calls for hand manipulation where the conditions are sometimes quite variable, owing to more or less intermittent operation of the feed pump. Sometimes the connection to the condenser is provided with a spring-loaded valve, so that when the exhaust pressure reaches a predetermined pressure, higher than that within the condenser, steam may pass to the condenser. The construction of the valves usually employed is such that the higher the pressure in the condenser, the higher is the pressure at which the steam will pass to the condenser, which is, of course, undesirable. A system which will automatically maintain a predetermined temperature in the feed heater at all times, bleeding the main turbine for this purpose, at high powers if necessary, and at the same time automatically permit any surplus steam not condensed in the feed water heater to do useful work in the turbine, is much to be desired.

Steam Pressures

The attention of central station engineers at the present time is being directed to employing higher boiler pressures, viz., pressures as high as 600 pounds. To-day 200 pounds pressure and 200 degrees Fahrenheit superheat are regarded as a more or less everyday operating condition for large plants. Steam generated at 600 pounds pressure, having exactly the same heat content as that contained in 200 pounds pressure and 200 degrees Fahrenheit superheat will have a superheat of approximately 128 degrees Fahrenheit. This, expanded to 29 inches of vacuum, is theoretically capable of giving 13 percent more energy than when generated at 200 pounds and expanded to the same vacuum. Doubtless, when operating under the high pressure conditions, the turbine will be of lower efficiency. The high pressure element will be less efficient on account of the great density and the small volume of the steam, and, on the other hand, the low pressure elements will be less efficient because of the great amount of water precipitated by the steam expansion from the high pressure, introducing a brake in the turbine. However, it is reasonable to suppose that the turbine will avail itself of at least 50 percent of this 13 percent possibility, producing a net saving of 6 or 7 percent.

Governing Arrangements

With the old reciprocating engines, racing in heavy weather was always to be reckoned with. While governing arrangements were sometimes furnished by the builder, they usually passed most of their existence in a storeroom locker. To-day the reciprocator may accelerate rapidly; it may generally run at proportionately higher relative speeds than the turbine, without injury.

With the direct connected turbine, governors used always to be fitted, but were subsequently found to be of no particular value because the small diameter high-speed propellers, always being given the maximum submergence, seldom came out of water with the vessel pitching. With the geared turbine the propeller dimensions revert to that of the reciprocating engine, and while, because of its inertia, the turbine and gear may accelerate less rapidly than the reciprocator, very material increased speeds would be destructive. Therefore, a very dependable regulating mechanism is desirable which must at least have some semblance of being able to regulate and must not be

a mere stop governor which on the speed reaching a predetermined limit will slam shut an automatic valve.

There is much difference of opinion concerning the relative merits of gear and electric motor drive. Discussion of this important matter is refrained from here in view of certain battleship installations now being carried out. Unquestionably these installations will be entirely successful and will fulfill all expectations, but whether the added complication, increased cost and weight of machinery, together with increased steam consumption per propeller horsepower, are warranted, can be shown only by the development of the future.

Discussion

It was pointed out by Professor H. C. Sadler that in all probability it would be advisable to be a little careful about adopting geared turbines for the merchant marine. Ignorance or carelessness on the part of operators, while undoubtedly accounting for some of the troubles, yet did not wholly cover certain of the difficulties which were making themselves manifest in this type of propulsion.

Notes on Launching

BY WILLIAM GATEWOOD

Abstract

In connection with the launching of large and heavy vessels, for which launching calculations are made, two conditions of the operation usually receive especial attention, the author explains. One is the pivoting pressure, or reaction on the ways when the stern begins to lift, and the other is the minimum moment against tipping.

After stating that the calculations, as usually made, are well known to naval architects and may be found described in the transactions of this and kindred societies and in text-books on naval architecture, the author proceeds with a bit of history.

Suitable provision for taking the pivoting pressure on the fore poppets was early recognized as essential, he begins. It was recognized, also, that some means of distributing this pressure is necessary, as theoretically the pressure is concentrated on the extreme forward end of the sliding ways. In the early days, the fore poppets were built of timbers on end, but it was soon noticed that this was not a good practice, as the compression of end grain wood is quite small compared with the compression when the grain is flat. By building up the fore poppets with the wood laid flat, an appreciable amount of compression occurs at the forward end when the vessel pivots, and the under surface of the sliding way is enabled to remain in contact with the upper surface of the groundway over an appreciable length, thus distributing the pressure between the two pairs of surfaces.

As the launching weight of vessels increased and the pivoting pressures changed from a few hundred tons to more than two thousand tons, some more definite means of distributing this pressure became necessary. The introduction in the fore poppets of a considerable depth of soft wood with grain flat seems to have served the purpose in some cases, notably in the launching of the *Lusitania* and *Mauretania*. A special rotating device or rocker formed as a segment of a trunnion has been used successfully, as described in volume 22 of the Transactions of this Society. Curving or cambering the forward end of the fore poppet cribbing to introduce a clearance for the adjustment of the bearing surfaces has been used, as noted in the discussion on the paper above referred to. Strips of soft wood especially proportioned to crush under pressure were used in the fore poppets of certain vessels launched on the Pacific coast, as described in volume 12 of the Transactions of this Society. The height and general construction of the fore poppet will determine what depth of cruising strips can be fitted, and the maximum crushing in inches which can be counted on will regulate the portion of the overlap of the ways which will be in contact.

The minimum moment against tipping is primarily the measure of safety against the lifting of the fore poppets from the ways and the bodily tipping of the vessel backwards as the center of gravity of the vessel passes the end of the groundways. Many of the smaller vessels have "tipped" in launching because it was considered too expensive to extend the ways a suitable distance under water. Usually, no damage has resulted from this practice, as the pressures have been comparatively small and the ways were so supported as to "give" appreciably during the tipping. The settling of the ways, compression of the packing and deformation of the bottom of the vessel all tend to distribute way-end pressure, but it is manifestly unlikely, if not impossible, that the distribution of pressure can be as indicated by the trapezoidal formula.

Although the cruising strips do not exert nearly as much pressure in returning to their original thickness as they do in being crushed, the author concludes, the recovery is appreciable, and there will be a considerable pressure exerted between the bottom of the vessel and the sliding way outboard of the end of the groundway. This pressure may be sufficient to break the sliding way if there is an appreciable crushing of the strips, as the sliding way has considerable rigidity. The excessive bending moment on the sliding way may be relieved by cambering the last few feet of the groundway.

Side-Launching of Ships on the Great Lakes

BY EDWARD HOPKINS

With the advent of iron and steel shipbuilding on the Great Lakes, together with the fact that the location of most of the yards was not advantageous for end launching, though occasionally small vessels are launched endwise, side-launching was adopted and has continued to the present day, and is receiving consideration and has been adopted in some new yards that have been established outside of the lake district.

The preparation of the ground for building ships that are to be side-launched is much the same as for ships built for end-launching, with the exception that the ship is on a level keel when building. This is considered by lake shipbuilders as a great advantage, not only for general accessibility and the saving of scaffolding and blocking, but everything is plumb from the keel, which being level no rake has to be considered.

As most of the ships are built on permanent berths, and as these berths run from 80 to 100 feet in width, this, with the inclination of the ways, usually from 1¼ inches to 1½ inches to the foot, assures a height of keel blocking from 4 to 5 feet, which gives good working room under the ship's bottom.

There are no extensive launching calculations required for side-launching. Illustrations may be had revealing how uniformly the ship is borne at all periods, and the time from the releasing of the vessel until afloat is so short that no undue stress is placed upon the structure. Of course, the necessary calculations for stability after launching are determined, no matter what method is adopted.

Side-launching is especially adapted for repair yards where the graving dry docks are used for launching slips, as may be seen in a plan of the Toledo yards.

The methods used and arrangement of the building berths for side-launchings are, for all practical purposes,

the same in all Lake shipyards. The methods and arrangements used by the Toledo Shipbuilding Company are aptly illustrative of this description. The cross-section of the building berth, however, which Mr. Hopkins uses to clearly illustrate the special points of his paper, shows reinforced concrete groundways and shoring stringers. The other berths used are of the usual type, with piling and timber shoring stringers, and supports for the groundways, which are usually of oak or fir. They are placed between the keel blocks about 10-foot centers, extending from the inside bilge to the water's edge.

On the concrete groundways noted above, the lower half is covered with oak flitch 6 inches thick, forming the groundway. The upper half is of the usual size timber launching way and is hinged about the center of the berth, so that it can be dropped down until needed for launching, giving free access to the space below the ship's bottom.

The arrangement of these ways and launching tables were made for a ship of 3,500 tons deadweight, of the type now building by this company for the Emergency Fleet Corporation. The dimensions of the ship are as follows: Length overall, 261 feet; beam, 43 feet 6 inches; depth, 21 feet. The length and beam are the maximum that can go through the canals from the Lakes to the sea.

While the time required for side-launching is very short, the launch is much more spectacular than an end-launch, there being usually a drop of from one to three feet off the end of the ways.

In a recent launching in one of the Lake yards, the drop from the end of the ways to the water was only one inch less than 14 feet. No damage resulted to the hull structure.

About three weeks before the date set for a launch, the groundways are placed, and a week later the packing is placed under the ship. The triggers and daggers, two sets at each end for a ship of this size, are put in position a week before the launch, and three days before launching two patent key-blocks are placed under the keel at each end, these being the last keel blocks left under the vessel. They assist in relieving the stress on the triggers until the last moment.

The triggers are levers, two at each end, pivoted against chocks secured to the groundways. Daggers or shores extend from a point on the trigger just clear of the chocks to the ship. At the other end of the triggers, bights of rope are turned, extending back and fastened to piles or other secure anchorage. These ropes are cut with axes by men when signaled. The triggers and daggers drop away and the ship is free to move.

The signal device used consists of three vertical semaphores, pivoted to a platform located at each end of the ship, on the lower or water side of the building berth and clear of the ship's way, in sight of each other and also in sight of the men who are to cut the ropes, holding the triggers.

About half an hour before launching, the wedging up or rallying is started; first on the upper or land side until the shores drop out, then on the lower side until the shores drop out; then again on the lower side, rolling the ship so that the keel blocks can be easily removed. The patent or key-blocks, as before stated, are removed last.

The first of the semaphore signals is dropped when all the shore and keel blocks are out, the second when the key-blocks are out. Usually, at this period of the operations, the ship has moved a little, which is followed up by the jack shores fitted at each end of the ship. If she has not moved, the jacks are worked until she moves. The ship is now ready to let go, and the last signal is dropped to cut the ropes, which is done simultaneously at both ends.

The data from launch of the 3,500 deadweight ton ship are as follows: Declivity of ways, 1½ inches per foot; launching weight, 1,170 tons; area of sliding ways, 289.5 square feet; tons; weight per square foot, 4 (will go as high as 9 to 11 on large ships); time from start to leaving ways, 6.5 seconds; velocity in feet per second, 9.08 feet.

Discussion

This paper was very well received. Among other advantageous features which side-launching possessed, Captain W. T. Donnelly emphasized the one of economy of structure. Launching-ways of this type were built at little cost as compared with the end type of ways, while the danger of faulty delivery of the vessel was proving negligible. So long as the hull was practically thrown into the water, as against a long and slow angle of glide, there would be no troubles encountered. Captain Donnelly strongly recommended side launchings.

Structural Steel Standardized Cargo Vessels

BY HENRY R. SUTPHEN

This paper is printed in full on page 695.

FRIDAY SESSION

On Vibrations of Beams of Variable Cross Section

BY N. W. AKIMOFF, ESQ.

Abstract

As a general rule, the author states, a vibration taken at random is a mixture of the fundamental with several harmonics. Any compound vibration can be decomposed by analysis, or by means of special instruments, into its primary elements (so-called normal modes), fundamental and overtones. Now, if there is any disturbing periodic force (such as an unbalanced engine), and if its period happens to be the same (or nearly so) as that of one of the normal modes of the free vibration, we have synchronism, where the effect is generally quite out of proportion to the magnitude of the disturbing force. For instance, the vibration due to a reciprocating engine is compounded of the fundamental, the first harmonic (of double frequency) and of the second harmonic (of three times the frequency of the fundamental); higher harmonics, as a rule, are not felt. Now, if any one of these frequencies is the same as any of the natural frequencies of the structure, its effect will be felt in a marked degree.

The reader, if unfamiliar with elastic vibrations in general, is advised to carefully study the fourteenth chapter of Morley's excellent book, "Strength of Materials," where many useful formulae will be found.

Experiments on Simplified Ship Forms

BY PROFESSOR H. C. SADLER AND T. YAMAMOTO

Abstract

The question of the simplification of ship forms is one that has received a good deal of attention during the past year. In their anxiety to produce a simple form from a structural standpoint, a good many designers not familiar with ships have ignored entirely the question of economical propulsion. During the past year some experiments upon "straight frame" forms were conducted in the tank at the University of Michigan, and the results are thought to be of sufficient interest to place the same on record. The main object of the experiments was to determine what difference in resistance existed between an ordinary shipshape form and one in which the curved form of the frames was replaced by straight lines. No particular attempt was made to develop the best possible form, but the main features of the two types were kept constant.

The diagonal line representing the corner was in all cases made a straight line, with the view that if the bilge corner were cut off this would facilitate construction. The results of the tests show that the effect of retaining the corner volume at the bilge is to increase the resistance about 3 to 4 percent, or approximately the same as that due to the added surface. Compared with the shipshape form, there is practically no difference in resistance between this and the simplified form with the corner cut off.

Although time did not permit of carrying out a complete set of rolling experiments, some of the models were tried and it was found that the effect of the sharp corner upon the reduction of rolls was most marked, and that even with the corner removed these models came to rest quicker than the shipshape form.

The general conclusions that may be drawn are, the author states, in closing, as follows:

1. Vessels of the straight frame type can be designed which will have about the same resistance as a shipshape form.

2. If the diagonal line of the corner be given the wrong slope, this will increase the resistance due to the lack of conformity with the proper stream line flow.

3. The effect of maintaining the square corner is to increase the bare hull resistance, but as vessels of this form would not need bilge keels the net result from a horsepower standpoint would be about the same as for a shipshape form.

4. Probably the best results from a resistance standpoint would be obtained by using diagonal line which is of a curved form in the body plan.

Variations of Shaft Horsepower, Propeller Revolutions and Propulsive Coefficient with Longitudinal Positions of the Parallel Middle Body in a Single-Screw Cargo Ship

BY NAVAL CONSTRUCTOR WILLIAM MC ENTEE, U. S. N.

This paper will be published in the January issue.

Recent Developments in Shipyard Plants

BY NAVAL CONSTRUCTOR S. M. HENRY, U. S. N.

Abstract

In this paper the author sets forth the nature of the difficulties overcome in bringing shipyards to a point of production commensurate with the demands imposed by the war and embraces all phases, such as building and repairing slips, crane service, structural shop, fitting-out crane, turret shop, forge shop, foundry and machine shop. He thanks the present demand for ships for the progress that has been found possible in the development of the plants. With a continued demand for more and larger ships, it is to be expected that the growth of the plants, which has been begun, will be rounded out so that each department will in its own line be able to compare favorably with the best shops doing a similar character of work in other industries.

Present Status of the Concrete Ship

BY R. J. WIG

Abstract

Establishing the fact that there is much interest throughout the world in the development of the concrete ship, the author declares that the use of reinforced concrete for ship construction has been suggested by the structural engineer and not by the naval architect. Like all innovations, the author continues, its development has been observed by some with much skepticism. The structural engineer has worked under a great handicap in not knowing the premises of ship design, and during these very busy days of the past two years it has been difficult to obtain the assistance of naval architects who could join the structural engineer in adopting this new material to ship structures.

Unfortunately, the structural design of ships in general has not been developed on theoretical grounds, but rather from empirical standards and experience. Reinforced concrete is such a radically different material from steel and has such dissimilar physical properties that it has been necessary to devote much time to theoretical analysis of the ship structures which is not undertaken at all in steel ship design.

The concrete ship is truly a product of necessity. We have been working on the concrete ship comparatively a very short time and therefore we do not expect the present ships to be the ultimate concrete ship; they must be judged as pioneers, and imperfections are to be expected. Since the concrete ship of large size (3,000 tons and over) is being developed almost wholly in the United States by the Emergency Fleet Corporation, a discussion of the present status of the concrete ship will be confined largely to a discussion of this work.

Torsional stresses are produced when the ship passes over the waves making an acute angle with the waves. In order to find what increase of stresses can be expected due to this effect, an analysis was made of the torsional moments and the stresses produced by them. To find approximately the wave condition giving the maximum effect, a rectangular waterline section was first assumed, width one-eighth of the length. The usual assumption was made that the hydrostatic water pressure varies directly with the depth under the wave surface. For the sake of simplicity, a sine wave was assumed instead of a trochoid, correction for the difference being made afterwards. As usual, the wave height was taken one-twentieth the length. The maximum torsion midship was then found to occur when the wave crest makes an angle of 19 degrees with the ship, when the line of the wave crest passes through the center of the ship and when the length of the wave is 0.475 times the length of the rectangular waterline section.

In addition to the analytical studies, it has been necessary to obtain data on the physical properties of structures of unique design and concrete mixtures which had seldom before been used in structural work. These structural investigations are made under the direction of W. A. Slater at the Bureau of Standards' laboratories at Washington and Pittsburgh, the laboratory of Lehigh University at Bethlehem, Pa., and the Office of Public Roads, Arlington, Va.

The investigations are made to establish safe working stresses and standards of design. Tests already made demonstrate the safety of the designs first made and indicate how weights may be further reduced without sacrificing strength.

Our general knowledge of reinforced concrete as compared with steel structures makes the success of its further adoption for ship construction appear a certainty, but actual experience is lacking and therefore its future cannot be predicted with absolute certainty.

The Application of Electric Welding to Ship Construction

BY H. JASPER COX

This paper will be published in the January issue.

Hog Island—The Greatest Shipyard in the World

BY W. N. BLOOD, JR.

This paper appears in full on pages 678 to 690.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Preserving Iron and Steel

The necessity for and the economy resulting from the protection of iron and steel by the application of proper inhibitive paint coatings has already been so well established that there is no longer need for argument. Those who have to carry out this work recognize that it is very necessary to have the proper paint. A large amount of information has been collected during the past ten years showing the results obtained by actual tests upon materials. There are certain paints and materials that accelerate corrosion. The use of these should be avoided. Other materials possess inhibitive properties, and their contact with the bare iron is actually desirable, since they retard rust. The tests relate chiefly to the priming coat—the coat which comes in direct contact with the bare iron or steel. In view of the fact that the base is limited to linseed oil, drier and a volatile consisting either of turpentine or mineral spirits, or both, the pigments available for this class of work require careful consideration. The pigment composition for succeeding coats is not quite so important and may vary according to the color desired. As a matter of fact, for finish work a paint that is satisfactory on wood surfaces will be equally satisfactory when applied on iron and steel.

Economical practice would recommend the use of two paints—the first, a good priming coat paint, possessing the necessary inhibitive properties; the second, a good oil paint of the desired color for finish coat work.

When three coats are applied—experience has clearly demonstrated the economy of three coats on new work—the paint for the second coat may be made by mixing one gallon of priming coat paint and one gallon of finish, and reducing this mixture with one quart of turpentine. This paint will differ in color from the other paints, hence it will not be difficult for the painter to make sure that the whole surface has been properly covered.

The pigment, red-lead, has been used for many years in the priming coat of paint for iron and steel. It belongs to the class of pigments known as inhibitors. Among other pigments supplying this quality is the basic-lead chromate known as "American vermillion." This pigment has a value far in excess of red-lead or similar pigments. No doubt the cost of basic-lead chromate per pound compared with that of red-lead has been the cause for a lack of effort on the part of paint manufacturers to introduce its use. As a result, its merits are not fully known by the consumer. Basic-lead chromate also possesses inherent physical properties which make it in the end less costly than red-lead. It weighs only half as much as red-lead to the gallon and possesses better covering qualities than red-lead paint of similar consistency. The basic-lead paint will keep indefinitely in the can in ready-mixed form, whereas a straight red-lead paint will settle out quickly on standing. Red-lead in paste form has a tendency to harden in the container if it is kept standing for six or eight months, and frequently hardening develops in a much shorter period. Basic-lead chromate paint produces a uniformly satisfactory coating, and never sags or runs on perpendicular surfaces. It resembles the light shade of red-lead in color.

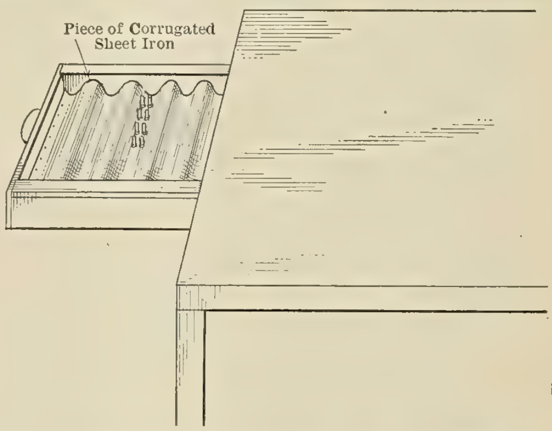
It is unnecessary to use basic-lead chromate straight. It may be extended by adding 25 percent of a chemically inactive pigment such as magnesium silicate, commonly known as "asbestine." A paint made from such a mixture has still hiding and spreading qualities equal to straight red-lead paint, and the inhibitive qualities are quite unimpaired.

A satisfactory basic-lead chromate should conform to the following specifications: (1) The pigment should consist of 25 percent basic-lead chromate and 25 percent inert pigment, such as asbestine. (2) The vehicle should consist of 90 percent pure linseed oil and 10 percent combined volatile and drier. (3) The paint should weigh 12½ pounds to the gallon. A paint complying with these requirements will give most satisfactory results.

Liverpool, England. Mark Meredith.

A Kink

During a recent visit to a small shop, I picked up this clever kink. The shop foreman, desiring to have several trays or separate small compartments in the various drawers of his small screw and pin cabinet, hit upon the idea of using some sections of corrugated iron. The scheme is shown in the sketch, the sections of corrugated sheet iron being cut to fit the drawers, which provided many small trays or troughs that had no bothersome square corners or sides. C. H. Willey.



Handy Drawer Compartment for Small Ware

Proposed Method for Obtaining Fresh Water on Ships

One of the problems of marine installations is the supplying of sufficient fresh water for make up and drinking purposes. The only source of ship's supply aside from storage is the evaporator. There are, however, several drawbacks to the use of evaporators. In the first place they require fuel. They also need constant attention, since the temperature of the condensing apparatus must be closely regulated and the salt accumulation removed to secure satisfactory operation. Furthermore, it is difficult, if not impossible, to provide for evaporators on certain

types of ships—Diesel, for example—although this circumstance is not particularly important, since it is usually practical to store the water necessary for the trip on these ships.

Accordingly it has occurred to the writer that the amount of water formed as a product of combustion might in many cases be utilized to advantage. Bituminous coals are composed of from 30 to 40 percent of volatile material.

An average of 10 percent of this volatile material is hydrogen. Consequently, for every ton of coal burned approximately 150 gallons of water is formed.

For oil-burning ships, whether Diesel or steam, approximately one and one-half barrels of water is formed for every barrel of oil burned. As the average large steamship burns one to one and one-half barrels of oil per mile, there results the formation of from 300 to 500 barrels of water in the products of combustion. Diesel ships of the same capacity would form about one-third of this amount; thus 10,000 to 30,000 gallons of water per day are part of the products of combustion of a Diesel or a steamship, according to the type and size. This exceeds the capacity of the average evaporator.

While the products of combustion are of high temperature—that is to say, from 1,000 degrees in uneconomical plants, down to 500 degrees in very efficient plants—the heat mass is very small, and a comparatively small condenser would cool these products and extract the water. The installation of a comparatively small condensing apparatus in the top of the smokestack would not interfere with draft —because of the reduction in volume of the products of combustion—and would probably save 75 percent of the water of combustion.

If the exhaust from a Diesel engine were led to an ordinary small auxiliary condenser this apparatus would be sufficient to salvage practically all of the water of exhaust. Such a device would also incorporate the functions of a muffler by reducing the volume of the products of combustion. In fact, since this process is directly opposed to the expansion by heat, which causes the noise of exhaust, the apparatus would be the only muffler necessary.

It is possible that water thus produced would taste of fuel or lubricating oil. In all probability skimming and filtration would make it perfectly potable. If the fuel and lubrication of the engine were well adjusted, however, and the engine were in proper working order it would not be necessary for the water to become contaminated in the least. Furthermore, the condensation of the water could be controlled by long lines of separation, such as are used in refining various chemicals. So that the oils and other volatile hydrocarbons would be collected by a preliminary condenser maintained at a temperature of, say, 300 degrees, and the pure water vapor then recovered in another condenser maintained at the minimum temperature possible.

The water obtained by this method would be ample for all possible requirements of a ship, since the needs would be more or less proportional to the power of the engine. This would be particularly the case in a Diesel ship where no fresh water is required except for potable purposes.

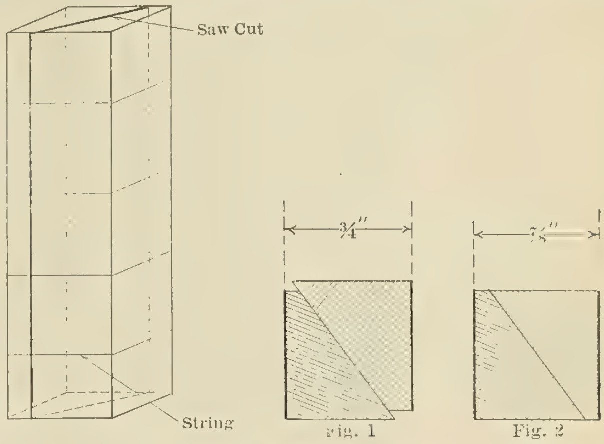
Oakland, Cal. Cole Newman.

How to Keep Main Feed Pump Gland Tight

Main feed pumps that are worked off the engine pump levers are, as a rule, most unsatisfactory on account of the difficulty of keeping the glands tight and so permitting loss of feed water. Owing to this, many an engineer has been at his wits' end wondering what he would try next.

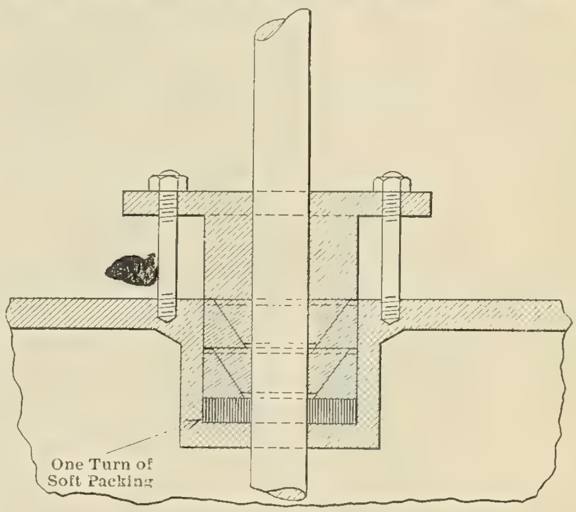
A remarkably efficient packing can be made with "square tuck's" canvas, rubber backed. If, for instance, the stuffing box requires a ¾-inch packing, order a ⅞-inch packing and proceed in the following manner:

Cut off the required length of packing, and, after gripping it in the vise, saw through, as shown, almost but not



Method of Cutting Packing

quite from corner to corner. With packing ⅛ inch larger than the stuffing box, it is better to put two saw blades together in the hacksaw. Having sawed the packing from end to end, tie the packing loosely with sewing twine or thin string, to allow it to enter the gland. When com-



Arrangement of Packing in Main Feed Pump

pressed by the gland, half the packing is wedged onto the rod, the other half against the stuffing box.

This type of soft packing has a much longer life than any of the other, owing to the fact that as it wears it can be nipped up again and again, until the wedge-like effect is destroyed. Figs. 1 and 2 in upper illustration show this.

Victoria, B. C. Edmund B. Dell.

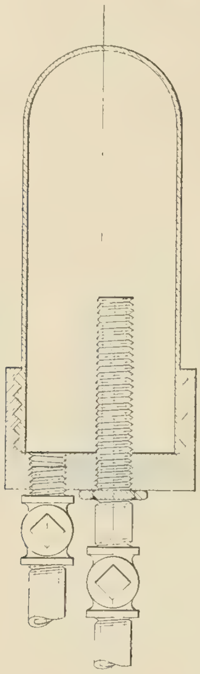
A Make-up Feed Telltale

The device, which is a make-up feed telltale, eliminates all guesswork connected with the amount of extra feed being used, and can be quickly constructed and affixed to any convenient place where it will be a constant reminder to the engineer on watch.

It is made of an old electric light watertight fixture. A by-pass may be inserted between the two pipes leading to and from the fixture, so that in the event of either of

the cocks becoming plugged up the device may be cleaned out without discontinuing the supply of feed.

The plug cock or valve on the line leading to the feed



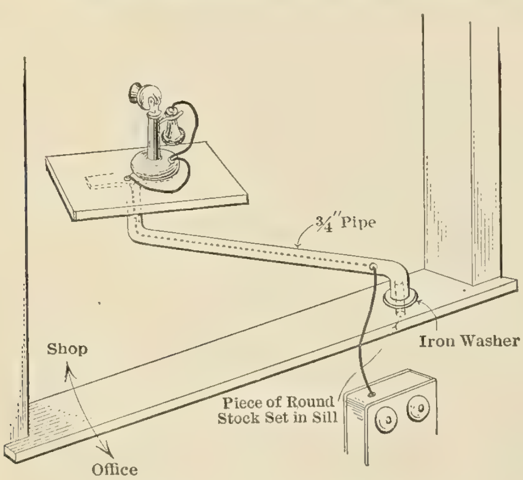
Section of Make-up Feed Telltale

manifold or tank is left wide open at all times, the amount of feed being regulated by the opening of the line leading to the condenser or air pump.

New York. J. G. K.,
Chief Engineer, S. S. *Drake*.

Telephone Swing Bracket

To enable the office desk phone to be used in both the office and shop, a novel stunt was employed by the foreman of a small shop. It is shown in the self-explanatory sketch. A piece of pipe, a board, and bit of round stock

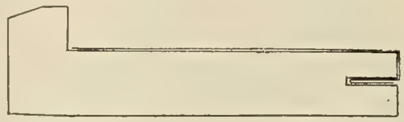


Swing Bracket for Supporting Telephone

are all that is needed. One end of the pipe is split and bent to Y-shape to hold the board. The other end is bent at 90 degrees and fits down over a piece of round stock set into the window sill. The phone cord runs inside the pipe, as shown. C.

Kink for Tightening Key

On several occasions the writer experienced difficulty in keeping some large keys tight in position, and as the material was not immediately at hand to make a larger key some alternative had to be found. We finally decided to use a strip of thin steel to supplement the thickness of



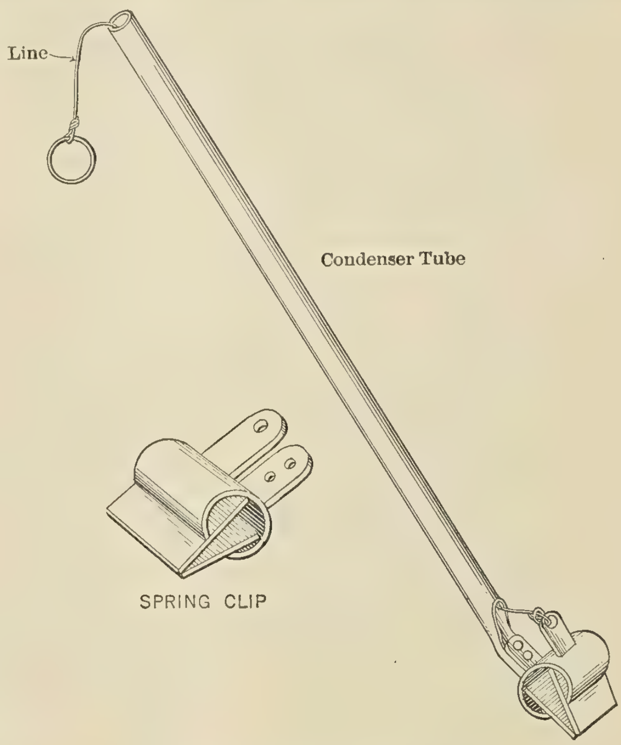
Filler Strip for Holding Key Tight

the key, inserting the filler as shown in the sketch, so that it would hold in position while the key was being driven. This strip of 1/32-inch steel driven in with the key in the manner shown proved to be the solution of the trouble, and no reports have yet been received that the job has come loose.

Philadelphia, Pa. W. A. Lailer.

Handy Pick-Up for Crank Pits

For recovering lost oil cans, cups and waste from the crank pits, a very handy device can be made from a length of condenser tubing and a large spring paper clip, as shown in the sketch. The paper clip is fastened to one end of the tubing by a couple of rivets, the end of the tube being split open and fastened for the purpose. A wire is passed through the tube, one end of it being secured to the handle of the paper clip, other end to a ring. To operate, the wire is pulled, opening the clip, with the clip end down in the pit. Upon releasing the wire the spring



Pick-up for Rescuing Lost Articles

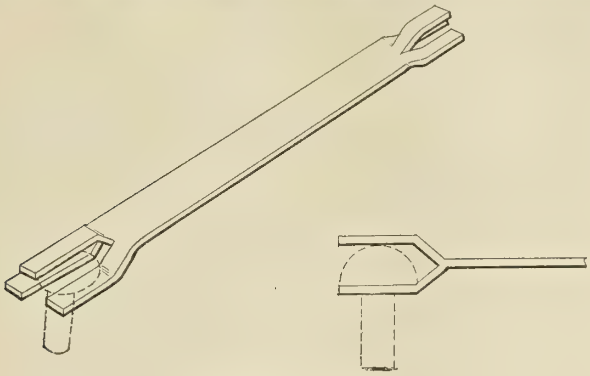
closes on the article and holds it. This enables the operator to draw up the article. The device ought to save its first cost many times over in the course of a year in "salvaged" material.

Concord, N. H. C. H. Willey.

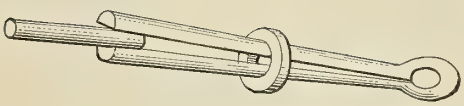
For Your Note Book

Here are two simple kinks that may be worthy of space in your note book. The writer himself found them so.

The rivet holder is made by splitting the end of a strip



Handy Rivet Holder

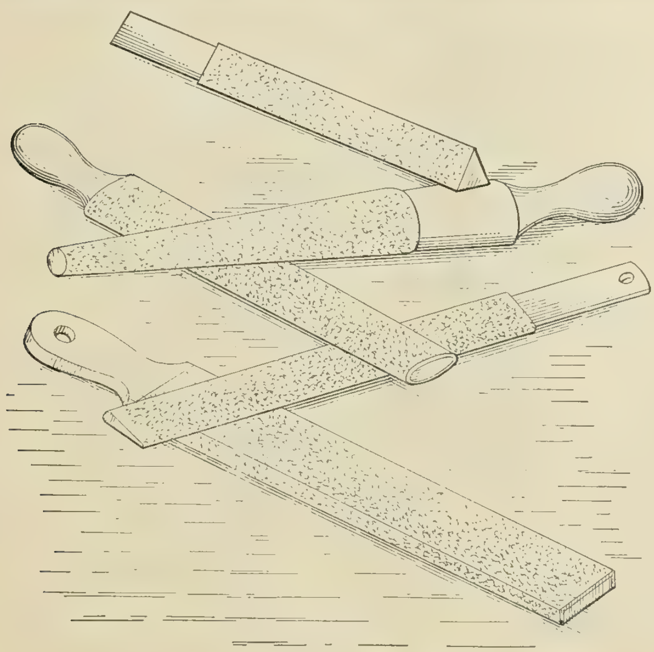


Handy Small Pin Holder

of band or strap iron in two places and then bending as indicated. The other kinks hardly need describing. A large cotter key and a washer provide a means of holding short, small pins while inserting them in valve rods of the ship's motor boat gas engine or other places. W.

Emery Cloth Sticks for Polishing Work

One of the oilers who cleaned the auxiliary machinery made up a set of emery cloth cleaning sticks for polishing

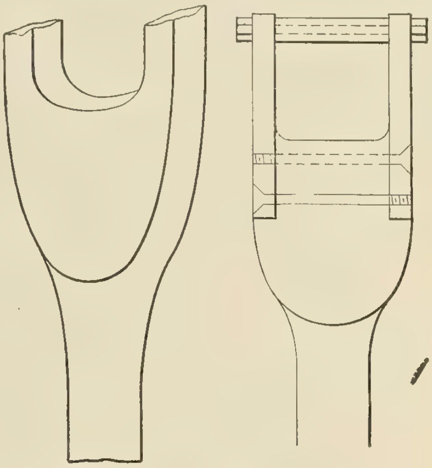


A Set of Emery Cloth Sticks

the sides of nuts, hooks and rocker shafts. The sticks are made of hard wood coated with fish glue, to which the emery cloth is applied, the various shapes permitting the work to be done very easily and neatly. Small tacks will hold quite as well as the glue, but the tacks will have to be sunk in so that the heads will not mar or scratch the work. H.

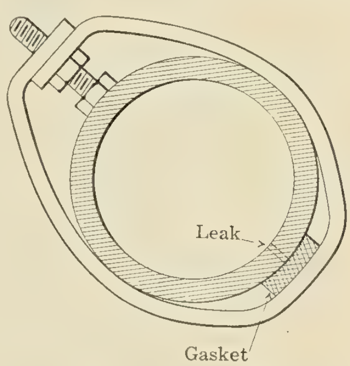
Handy Repairing Kinks

I am sending you herewith two kinks which I feel will be of interest. One shows a handy way of repairing broken shovel handles, and the other is an emergency



Repairs to Broken Shovel Handle

patch for pipe leaks. The broken wooden shovel handle was repaired as shown. The sides of the handle were planed down to a depth equal to the thickness of metal which was used in the repair job. Three-eighths to one-half-inch stock will serve. After being fitted to a handle, these are drilled and quartered, or 3/8-inch rivets set in and riveted over. The top of the metal parts also is drilled and an extension piece set in—preferably a piece of 3/4-inch pipe and a bolt used to pull this fast. This makes a good serviceable top, and the new handle will probably outlast the metal plate in the shovel itself. The emergency patch on the pipe is nothing more or less than a bit of gasket placed over the leak and made secure by means



Emergency Patch for Pipe Leak

of a piece of flat metal bent around the pipe. In order to take up the slack on the gasket, a set screw is placed in the band opposite the leak and so screwed up as to make an effective job. This is a cheap arrangement, but serves in cases of emergency, as it has more than once in my own experience.

Concord, N. H. C. H. WILLEY.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY "NAVAL ARCHITECT"

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number if from examination for grade of chief, and by a dagger (†) if from examination for other grades.

Strength of Bracket

Q. (985).—Given a brace of flat steel bar, three inches wide and one inch thick, bent to form a brace as shown in the figure, fastened to a bulkhead by four rivets as shown, required the maximum load *W* and diameter of rivets. Give force diagram and reference in Merriman's "Strength of Materials," or some similar book.

A. (985).—The problem as outlined is not very practical, since the material is not distributed in such a manner as to produce the proper amount of strength, as will be shown in the following comment:

The method of tackling the proposition may be outlined thus: We may quite properly assume that the bar is hinged at points *A*, *B*, and *C*, Fig. 1, for the purpose of determining load *W*. This is not far from the actual conditions and, further, makes our calculations easier. It is

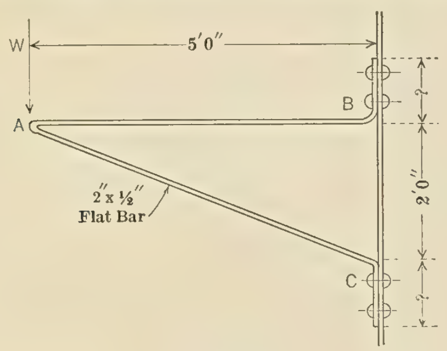


Fig. 1

clear from looking at the brace that with the weight acting downward, the member *AB* will be in tension and *AC* in compression. Now, if we weighted the bracket until it gave way, we should find that this occurred by the compression of *AC*, so that the strength of this member is the determining factor.

Now *AC* is virtually a column, pinned at the ends, and should be designed as such. Turning to page 291, Carnegie Pocket Companion (1917), it will be seen that the ratio of length to the radius of gyration, which is a measure of the stiffness of columns, should not be over 120 for members under constant stress. Now the radius of gyration is defined as

$$\sqrt{\frac{I}{A}}$$

where *I* is the moment of inertia about the axis through the center of gravity of section and *A* is the area of section. The axis would be the one giving the least radius of gyration. If we consider the proposed section, we have as radius of gyration =

$$\sqrt{\frac{\dfrac{bh^3}{12}}{bh}} = \sqrt{\frac{h^2}{12}} = \sqrt{\frac{(\frac{1}{2})^2}{12}} = .144 \text{ inch.}$$

The length of the member $AC = \sqrt{(60)^2 + (24)^2} = \sqrt{4{,}176} = 64.6$ inches. Hence

$$\frac{\text{Length of } AC}{\text{Radius of gyration}} = \frac{64.6}{.144} = 448,$$

a value much above the 120 shown to be permissible.

It is undoubtedly true that the bracket in Fig. 1 would bear some strain, but the metal is not well proportioned, consequently let us replace the present brace with one

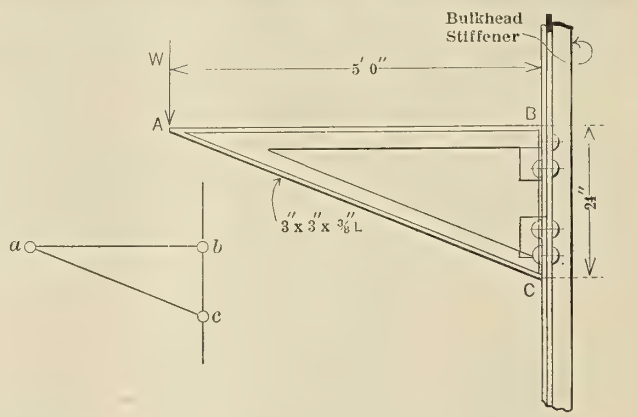


Fig. 2

made of 3-inch by 3-inch by ⅜-inch angle bar. It is true that this is much stiffer at points *A*, *B* and *C* than was the flat bar; we shall, however, still consider the frame jointed as suggested by *a b c*, Fig. 2, for sometimes the bar is not welded at points *B* and *C* as shown in Fig. 4; furthermore, the calculations are straightforward.

Our first step will be to find the maximum value of *W* which can be carried by our 3-inch by 3-inch by ⅜-inch angle. The member *AC* will be the determining feature. Its length is $\sqrt{(60)^2 + (24)^2} = 64.6$ inches.

The minimum radius of gyration for a 3-inch by 3-inch by ⅜-inch angle is .58 inch (Carnegie Pocket Companion, 1917. Page 185). The radius of gyration for practically all structural sections in common use has been worked out and tabulated as here seen.

The allowable stress in compression is

$$19{,}000 - 100\frac{L}{r} = 19{,}000 - 11{,}100 = 7{,}900 \text{ pounds per square inch.}$$

Since the area of this angle equals 2.11 square inches, for the allowable load on *AC* we have $7{,}900 \times 2.11 = 16{,}700$ pounds.

A consideration of the frame at *A* shows us that the member *AB* will exert a pull or tension and the member *AC* compression, which we may denote as F_1 and F_2 re-

spectively. This is shown in Fig. 3, which also illustrates the triangle of forces. Since this triangle is similar to *ABC*, Fig. 2, we may find by proportion W and F_1; F_2 being taken as = 16,700 pounds.

$$\frac{W}{F_2} = \frac{24}{64.6} \text{ or } W = \frac{24 \times 16{,}700}{64.6} = 6{,}200 \text{ pounds.}$$

$$\frac{F_1}{F_2} = \frac{60}{64.6} = F_1 = \frac{60 \times 16{,}700}{64.6} = 15{,}500 \text{ pounds.}$$

Should the angle be half cut away at B, we should have a stress of tension $= \dfrac{15{,}500}{3 \times 3/8} = 13{,}800$ pounds per square inch, which insures us a factor of safety four to five. This is rather low for ship work, but corresponds fairly well with an allowable tension of 16,000 pounds per square inch, the

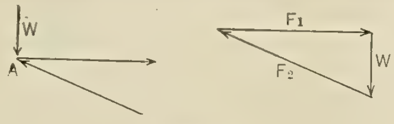


Fig. 3

limit designated by the American Bridge Company. In cases where W is not a fixed load, or where the failure would be dangerous, a factor of safety of 6 or more could be produced by reducing the value of W.

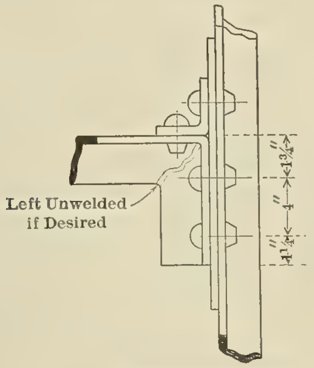
Of the fastenings to bulkheads, that at B is most vital, since here the rivets are in tension, which should be avoided as far as possible. Erecting and riveting is difficult where only one rivet is employed. The simplest method is to provide enough rivets to take by direct tension the force in arm AB. Using two 3/4-inch rivets, we have for the stress (if borne equally by them)

$$\frac{15{,}500}{2 \times .442} = 17{,}500 \text{ pounds per square inch.}$$

As this is rather high, we had best place a clip between bracket and bulkhead, as shown in Fig. 4. Our rivet stress in tension will then be

$$\frac{15{,}500}{3 \times .442} = 11{,}700 \text{ pounds per square inch.}$$

The rivets at C are subjected to a shearing force. This will equal the component of force F_2 acting along the line



CONNECTION "B"

Fig. 4

BC, and will be found equal to W. Since the shearing area (sectional area) of a 3/4-inch rivet is .442 square inch, the shearing stress is

$$\frac{W}{2 \times .442} = \frac{6{,}200}{2 \times .442} = 7{,}020 \text{ pounds per square inch,}$$

a value which is sufficiently low. Fig. 4 indicates proposed dimensions for riveting to bulkhead at B.

In the case of this bracket, it should be noted that a better design would be obtained by making BC more than 24 inches; also, it is to be seen that side strain is not provided for in the example submitted. In the analysis of the problem, we have taken the length of the different members along the heel of the angle instead of along the neutral axis. Fuller and Johnston's "Applied Mechanics," Vol. I, pages 16-26, will be found to include a somewhat similar problem.

NEW BOOKS

Ship Construction and Calculations. By George Nicol. Size, 6 3/4 by 9 inches. Pages, 502. Numerous illustrations. Glasgow, 1918: James Brown & Son. Price, 21s.

To all men of the merchant marine a more or less intimate knowledge of naval architecture is essential. To the officer mariner the subject may now be said to be a compulsory one, in that those who wish to qualify for the certificate of extra master must pass an examination in it. Besides this, there are other good reasons why an officer should have something regarding the construction and theory of ships. For instance, it would enable him, if called upon, to act as inspector on behalf of his employers at the building of a new vessel or the repair of an old. "Ship Construction and Calculations" is a book which contains fourteen chapters which are given over to ship calculations, moments, centers of gravity and buoyancy, details of construction, sheering forces, stresses and strains. Embraced in its table of contents is a chapter devoted to types of cargo steamers, another to the equilibrium of floating bodies, metacentric stability and the like. The type is agreeably large and the binding, which is of full cloth, makes a very presentable volume. The subject is well handled, not being too technically written, and yet containing sufficient formula to make it of value to the marine engineer. It is liberally illustrated with curves and charts, amidship sections of vessels, and takes up every phase of ship construction. The book is a really well-worth while addition to marine engineering literature.

New Records in Speeding Up Ship Machinery Production

Hardly a day passes in the Essington Works at South Philadelphia that some one of the many departments does not make a new record in the production of ship propelling machinery. Although the factory has not yet been completed a year, and will not be able to operate at full capacity for some time to come, in production, the shops are already ahead of their schedule. Handicapped by lack of labor, the company has even commenced to operate part of the blading section in the turbine department by women; other women, engaged for the steel metal working department, are turning out sheet steel boxes and lockers as the men used to do.

It is officially stated that the press crew in the forge shop, consisting of twelve men working on the 1,000-ton hydraulic press, increased its output from 83,000 pounds on Monday of last week to the maximum record for Friday of 105,000 pounds. This crew produces steel forgings for turbine and reduction gear axles, for ship propeller shafting and tail shafting. In the foundry the average output per day now amounts approximately to about 300,000 pounds of gray iron.

Shipbuilding and General Marine News

**Contracts for New Ships—Shipyard Improvements—
Engineering Projects—Improved Appliances—Personal Items**

NEW SHIPYARDS AND EXTENSIONS OF EXISTING YARDS

Additions, Improvements and Orders for New Equipment

The Delano Shipbuilding Co. has been organized in Delano, N. J., by Walter D. Prouse, Henry F. Miller and Andrew H. Haig.

The Anchor Shipbuilding Corporation has been organized at Washburn, Wis., and has acquired a 125-acre site at Chequamegon Bay. Wildmar B. Nicolysen, Duluth, Minn., is president and general manager.

The Federal Dry Dock & Repair Co., Hoboken, N. J., has been organized by Wm. W. Corlett, Kenneth B. Halstead and Edward F. Briggs, Hoboken.

The Clark Martin Shipbuilding Co. has been organized by G. W. Clark and A. M. & M. H. Salzer, 925 St. Marks avenue, Brooklyn, N. Y.

It is reported that the Manitowoc Shipbuilding Co., Manitowoc, Wis., will add a complete foundry unit to its plant, at a cost of about $150,000.

The National Shipbuilding Co., Orange, Tex., will build a plant at Galveston for the purpose of equipping the wooden ships constructed at its yard.

The Northport Shipbuilding Corporation has been incorporated by T. J. Fallon, M. S. Reeves and R. Burk, 1482 Broadway, New York.

The Newbern Shipbuilding Co. has been organized by J. F. Rhodes, W. F. Aberly, F. G. Heyman, George S. Bennett, and L. I. Moore, all of Newbern, N. C.

The Connecticut Ship & Construction Co. has been organized by Frank H. Andrews, Albert H. Powers and Matthew A. Reynolds, New Haven, Conn.

The Rockport Shipbuilding Co. has been organized by E. M. Leavitt, E. McLean and D. L. Fogg, all of Augusta, Maine.

The Watercraft Construction Co. has been incorporated by A. Lennon, F. B. Wood and W. J. Doyle, 233 Broadway, New York.

The Union Shipbuilding Co., Fairfield, Md., has given a contract to Hughes Foulkrod Company, 1201 Chestnut street, Philadelphia, to erect ten ship ways and additional buildings.

The Langell Shipbuilding Corporation has been organized at St. Clair, Mich. The president is Gus Hill and the vice-president, Daniel E. Lynn, both of Port Huron, Mich.

The Ambursen Construction Co., 61 Broadway, New York, will establish a shipyard at Little Ferry, near Hackensack N. J., for the manufacture of concrete vessels for the Government.

The Honolulu, T. H., Chamber of Commerce has endorsed a plan to spend $9,000,000 for the improvement and extension of Honolulu's harbor.

The City of Natchez, Miss., W. G. Benbrook, Mayor, is planning to build terminal facilities, including docks, etc.

Secretary of the Navy Daniels is reported to have promised Mayor Peters, of Boston, Mass., that besides the prompt completion of the Massachusetts dry dock, the Federal Government will immediately begin work on the construction of several piers on the South Boston flats, which the national authorities are taking over, now that both branches of Congress have passed the bill.

The Bureau of Yards & Docks, Navy Department, Washington, D. C., is having plans prepared for a pattern shop in the League Island Navy Yard, Philadelphia, to cost more than $500,000.

The Swedish Government is reported to have ordered the building of a new dry dock at Beckholmen, near Stockholm, capable of docking a steamship of 10,000 tons.

The Pacific Coast Shipbuilding Co., Suisun, Cal., is understood to be arranging for a stock issue of $1,000,000 for proposed extensions and improvements. The plant has a 200-acre frontage on Suisun Bay and has an annual capacity of about 100,000 tons.

L. H. Rogers, 15 Broad street, New York, states that he is representative of the Concrete Ship Corporation, a Delaware concern, capitalized at $2,000,000.

The Buffalo Dry Dock Company, Ganson street and the Buffalo River, is building an addition to its punch shop to cost $20,000.

The San Diego Shipbuilding & Dry Dock Company, San Diego, Cal., is negotiating for property on the tidelands, between Front and Sixth streets, as a site for a new plant. The proposed works will cost about $100,000 for initial installation, and will be devoted to the production of steel and wooden vessels. Adam Weckler is vice-president and general manager.

The Todd Shipbuilding Corporation, 15 Whitehall street, New York, with yards at Brooklyn and Hoboken, is having a new 10,000-ton drydock constructed at the shipyard of Harry Cossey, foot of Henry street, Tottenville, Staten Island, N. Y. It will be built in four sections, each 90 feet long, 114 feet wide and 45 feet high. Extensions are being made at the Cossey yard to increase the capacity. Property on the north side of the yard is being filled in to allow for expansion.

The Todd Dry Docks, Inc., Seattle, has completed plans for a two-story pipe shop and mold loft, 34 by 100 feet, to cost about $5,000.

Construction has begun on a new one-story machine shop for the Southwestern Shipbuilding Company, East San Pedro, Los Angeles, as an extension to the present shop.

PROGRAMMES FOR SHIPBUILDING IN FOREIGN NATIONS

Further Shipbuilding Projects in Sweden

A large shipping company is being formed, it is announced, at Bergen, Norway, with a capital of 12,500,000 kroner, of which 6,500,000 kroner has been subscribed privately. The company, which will be named Britannia, with registered office at Bergen, will be managed by the shipowners, Otto Andersen and Mr. Christiansen. The subscribers, who include a number of the most prominent shipowners and business men of Bergen, have secured for the company five English post-war contracts for a total amount of $6,650,000, or an average price of $132.50 per ton deadweight. The vessels have been contracted for on the usual English sliding scale basis, based on prices in England in the autumn of 1917. The five vessels have the following deadweight tonnage: 8,400, 9,250, 10,800, 10,800 and 10,800 and are of the closed shelter-deck type.

English Shipbuilding Developments

Two large new berths have been constructed at the shipyard of the Northumberland Shipbuilding Company, Howdon. The scheme involved the construction of a new river frontage of piling and the reclamation of the land behind. Full possession of the site was only obtained on April 11, but the work was so well organized that the keel of the first vessel was laid on April 18, and the second keel on July 16. Both vessels will be launched before the end of the year. About 120 men each day and sixty each night were employed, as well as a number of women, who acted as ordinary laborers. The berths are 460 feet in length, are constructed of reinforced concrete, and can be used for the building of the heaviest type of vessel. One feature of the equipment is two steel gantries, each 60 feet in height, constructed on pipe foundations, which carry electric traveling cranes between the berths. The work involved the excavation of some 20,000 tons of earth, the driving of between 600 and 700 piles of steel and timber, the construction of 300 cubic yards of reinforced concrete and the erection of 300 tons of steel work.

Post-War Trade Anticipated

Norway, Sweden and Denmark are taking steps, as are other countries, to improve their principal harbors, largely vith a view to dealing more actively with German competition when peace is signed. In this connection special men-

tion is made of Malmo, Stockholm, Gothenburg and Copenhagen, more than one of which will probably be considerably enlarged and established as free ports. Already the Norwegian Government has decided upon extensive developments as the result of a comprehensive report presented by a special commission. This programme will, it is believed, meet the increased requirements of the national shipping interests, and thus assist in making the country independent of transit trade by way of Great Britain and Germany.

Advices from Copenhagen also state that a Swedish shipping concern has applied to the Swedish Government for an advance of 2,000,000 kroner out of the funds for loans to shipping. This company intends, it is stated, as soon as the present difficulties attending navigation are removed, to establish a number of lines having as their terminals, Hamburg, Cologne, Riga, Amsterdam, Antwerp, Rouen, Bordeaux, London and certain other foreign ports which remain to be determined. The starting of a service to the Mediterranean, as well as lines between Finnish and Russian ports, are likewise projected.

Canadian Merchant Marine Plans

The Dominion Government is to build ten large steel steamers in British Columbia shipyards, the value of the contracts approximating $16,000,000. The firms securing contracts are: J. Coughlan & Sons, four steamers, 10,000 each, at Vancouver; Wallace Shipyards, four steamers, 8,100 tons each, at North Vancouver; Victoria Machinery Depot, two steamers, 8,100 tons each, at Victoria.

Some months ago the Dominion Government announced that it would take full charge of all steel shipbuilding in Canada, and among the first orders placed were some with the Wallace Shipyards. The big Coughlan yard was engaged on orders for Chambers & Co., of Liverpool, and Raeburn & Verel, of Glasgow, and will be busy on these contracts until January.

The first vessels, two steel steamers of 8,100 tons, will probably be ready to be launched by Christmas. As fast as present British orders are being filled the Canadian yards are being worked to capacity on Dominion-owned vessels. It is planned to have the Government-owned steamers distinctly named, the word "Canadian" forming part of each name. Canada will have a distinctive Canadian mercantile marine flag for the Government-owned ships. A design has been approved and will be authorized for use shortly. It will be the regular British Union Jack, but with an anchor and beaver on the ensign. The new flag will likely be floated first on the Government steel vessels which are now being constructed.

Concrete Shipbuilding at Christiansand

The Sorlandske Staalbeton Skibsbyggeri A. S., at Vanse, near Farsund, in the Christiansand district, has just launched its first concrete boat, a 250-ton lighter, and has on its docks a second vessel of similar dimensions ready to be launched. The company has also under construction a 600-ton vessel, which will be equipped with a 320-horsepower Bolinder engine, and a 1,000-ton vessel, to be equipped with a 360-horsepower Diesel motor. These vessels are all for the Nordisk Export & Import Company. The shipyard is favorably located and in close touch with the Listied Canal, now in process of completion. It controls patents for a type of vessel to be used as salting houses. These vessels are intended to follow fishing fleets to their places of catch, and there be used for the immediate salting down of the fish in basins along both sides of the vessel, the salt reservoirs being in midships between these basins.

Delaware Shipyards Seeking Contracts

Privately owned shipyards along the Delaware River are seeking contracts for ships abroad as well as from firms in this country. Many ships must be built and the Delaware River shipyards are prepared, it is said, to turn out ships in any number. No more attempts will be made at record-breaking, but the men will be asked to do a full day's work in eight hours. It is claimed the Pusey & Jones Shipyards will no doubt receive many of the contracts for rebuilding the Norwegian merchant marine, as the company is a Norwegian organization. As soon as the Government releases control of the two plants the Pennsylvania yards will begin building 12,000-ton ships and the New Jersey yard 5,000-ton ships.

Work at the Davis Shipyard

The hull shown in the illustration, which was launched by M. M. Davis & Son, at Solomons, Md., on October 12, is of oak and yellow pine, 133 feet length over all; 125 feet length between perpendiculars; 29 feet beam and 15 feet depth. Two boilers of the single-end Scotch type are fitted. The boat will be propelled by a 1,000-horsepower triple expansion engine of the vertical inverted surface condensing type, having cylinders 18 inches, 28 inches and 45 inches in diameter by 30 inches stroke, and with the built-in type of condenser, the engine being built by the Bay State Iron Works Corporation of Erie, Pa.

The hull of the seagoing tugboat illustrated was recently built for the Bethlehem Steel Corporation, Sparrows Point, Md., and is the same as the first eight tugs which the company is now building for the Emergency Fleet Corporation, with the exception of slight changes in the superstructure.

Hull for U. S. Shipping Board

The Davis shipyard, which has six building ways and makes a specialty of tugs and barges, has built and launched up to date this year seventeen vessels, and has at the present time eight on the ways. This yard also has under contract for the Emergency Fleet Corporation twelve seagoing wooden tugboats, 150 feet long over all, to be furnished with the same propelling machinery as the first eight boats.

Japan Increases Pacific Service

Japanese services are being constantly increased. The Mitsu Bishi Kaisha is establishing new lines from Kobe to Singapore via Hongkong and Manila; from Amoy to Singapore by way of Hongkong, Bangkok and Indo-China ports; from Singapore to Borneo and the East Indies generally, and from Formosan ports to the Philippines by way of Hongkong.

Future extensions may be judged from a knowledge of recent shipbuilding developments. During the first half of the year Japanese yards launched sixty-five steamers of over 1,000 tons each, and having an aggregate tonnage of 193,417. This is 74,079 tons more than in the same period last year. The figures for the second half of this year will probably reach a tonnage of 200,000, or 400,000 in round numbers, for the year. If small boats are included the annual production will total 500,000 tons, which is considered remarkable when compared with the annual tonnage of 50,000 launched before the war. Up to the end of August last the Japanese Government had received this year as extraordinary revenue from marine insurance a sum of nearly 10,000,000 yen.

Built for Bethleham Steel Corporation by M. M. Davis & Son, Inc.

De Laval Method of Oil Reclamation

The De Laval Separator Company has recently perfected a machine for oil reclamation—especially for the saving of oil in steam-driven marine power plants.

As is well known in such plants, the bearings and, in the case of turbine-driven units, the reduction gears are lubricated with large quantities of oil flowing over the moving parts. Some of these bearings and parts are cooled by water circulation; others are cooled by oil circulation. In either case, it is inevitable that some of the water will find its way into the oil system. Another source of water in oil results from the sweating of oil storage tanks. The presence of water, especially of salt water, in machinery, has always caused trouble because of the rusting of the parts; its admission to bearings and other moving surfaces causes uneven lubrication, resulting in uneven and excessive wear. Naturally, the removal of this water is essential for satisfactory power plant operation.

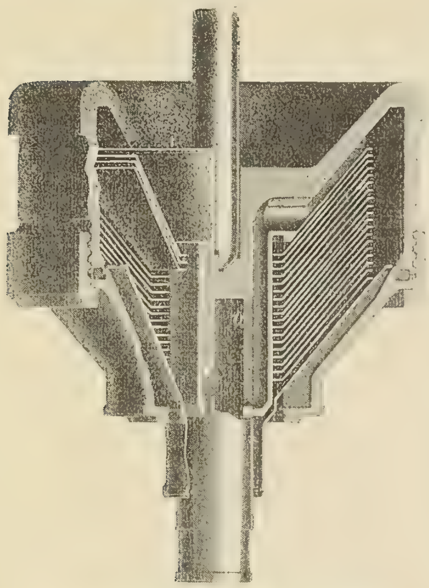


Fig. 1.—Sectional View of Purifier

The company claims that the De Laval method will remove not only all the water from the oil but also small particles of metal, dust and grit which come from the wearing surfaces and in various other ways are introduced into the oiling system. It will also eliminate core sand particles and pipe scale, which are particularly in evidence in new installations.

The oil purifier is installed between the overhead supply tanks and the drain tank, and so placed that it can be used to purify all or a portion of the oil. As installed the operator may clearly see the action of the purifier. Since the water and the oil are entirely separated, no matter how much or how little of each is present, the operator can notice the presence of water in the system by watching the discharge. The De Laval purifier will handle a large quantity of oil. It is positive in action and is not affected by the motion of the ship. The whole installation occupies less than two square feet of floor space. The company claims that after purification the used oil is as good as new; the dangers of a clogged oil system are thereby eliminated, and the factor of safety originally calculated by the designers maintained.

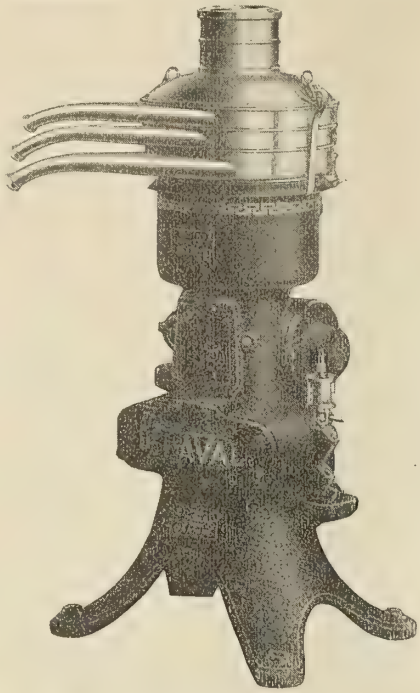


Fig. 2.—Steam-Driven Oil Purifier

The machine consists essentially of a cast iron frame provided with suitable bearings for supporting a vertical spindle which carries the purifying bowl at the upper end. The weight of the bowl and spindle, together with any thrust due to driving, is taken by two tread wheels, on which the polished end of the spindle rests. The bowl spindle is held in an upright position by a flexible spring-collar surrounding the upper bearing. The spring-collar permits a small amount of lateral motion and allows the rapidly revolving bowl to assume an unrestrained position. Surmounting the bowl are three covers, arranged to serve for overflow oil and water discharge, respectively. At the top of the overflow cover is located the regulating cover into which the oil to be purified flows. This cover is provided with a removable strainer to eliminate the larger particles of foreign matter from the oil before it reaches the bowl. The purifier is either motor-driven or steam-driven. The steam-driven type is here illustrated.

The capacity of the purifier is 300-350 gallons per hour. The weight for motor-driven style, 750 pounds net; turbine-driven style, 650 pounds net. The purifier is also made in a smaller size, either steam or motor driven. Capacity of the smaller size is 100 gallons per hour; the weight of the motor-driven type in this size is 390 pounds net; steam-driven purifier, 290 pounds net.

The arrangement of the rotating parts is clearly shown in Fig. 2. The worm screw is multiple threaded, having eight threads. The proportions are such that the speed ratio between the spindle and the worm wheel is about ten to one; that is, with a speed of 700 revolutions of the belt pulley the bowl will make 7,000 revolutions per minute.

When the bowl is revolving at the proper speed the oil to be purified enters the central tubular feed shaft and passes downward and out through slots into the channels in the distributor. From thence it passes through the holes in the bottom of the distributor to the disc separating space in the bowl. Here, due to centrifugal action, separation takes place. The material which is heavier than the water, such as sand and metallic particles, is thrown outward to the periphery of the bowl, and held there in the sediment pocket by centrifugal force. The water, being heavier than the oil, also passes outward and upward along the outer edge of the discs to the discharge outlet. The oil passes inward between the discs toward the central shaft, thence upward to the discharge outlet. Surrounding the outlets are the liquid cover and the sludge cover, so arranged that centrifugal force throws the liquids from the outlet openings into the covers, whence it is conducted to the proper receptacles by the attached spouts. If at any time the bowl should become clogged by a large amount of dirt, so that the liquid could no longer flow through, the inlet tube would fill up and overflow. By using a third cover the overflow is kept separate and acts as a warning signal that the bowl needs cleaning. The action of this oil purifier in marine installations keeps the oiling system free from water and solid material, thereby insuring longer life of the bearings and other wearing surfaces, and greatly reducing the liability of burned-out bearings and other destruction.

Alternating-Current Arc Welding Machine

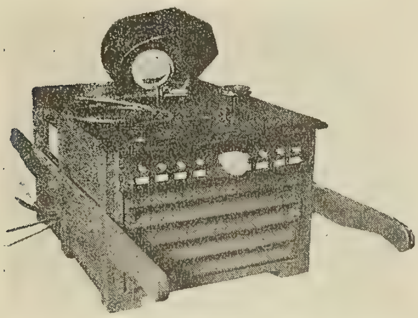
As is well known, electric arc welding, cutting and repairing is accomplished by the application of the heat occurring when the electric current jumps a gap in its circuit. Heretofore the apparatus available for this purpose has employed direct current at the arc which, in the case of either an *A-C* or *D-C* power supply, required a heavy motor generator set and an elaborate switchboard. For general weldings this means a 10- to 15-horsepower motor, and 8- to 10-kilowatt generator, with switchboards for both. With starting apparatus, the whole set weighs from one to two tons.

A new method for holding and controlling an alternating-current arc has just been introduced by the Electric Arc Cutting & Welding Company, Newark, N. J. They are now putting on the market a lightweight A-C welding machine consisting of a special transformer with no moving parts which will last indefinitely, the company claims, and do all that the D-C machines accomplish and a great deal more.

A few features of this new machine merit emphasis. Some D-C machines strive for constant volts and some for constant current, but it is one of nature's laws that the heat in the arc is the product of both the current and the voltage across it, which is synonymous with energy, and hence heat. The ideal condition is the constant product of current and volts. The company holds that their A-C machine does hold the heat of the arc automatically and substantially constant for any given setting.

Any experienced operator can weld from almost any source of D-C power supply, if he is provided with the means of holding the current substantially constant, as his steady, practiced hand will

hold constant voltage across the arc, and hence approximately, constant heat. It is this feature, the absolute necessity for skilled operators, which has held the electric arc back. The A-C machine, without moving parts, easily holds this arc wattage without special skill on the operator's part. Hence heat is substantially constant for any given setting. As soon as the operator becomes accustomed to the sound and sight of the arc, and can deposit the molten metal where he desires, the company claims it is absolutely impossible for him to burn the metal from too much heat or to make imperfectly joined, or "cold-shot" welds from too little heat. Of course, different metals, electrodes and conditions in shops require various amounts of heat and varying temperatures. These adjustments are obtained by an easily adjusted handle on the special transformer with taps arranged on the plugging board. The transformer is 80 to 90 percent efficient, the company holds. This high standard of welding efficiency is possible because but one simple change is made in the energy, and hence only one loss is added to the essential heat required to melt a pound of metal.



Electric Arc Cutting and Welding Machine

Due to the weight of D-C machines with their motor generator and switchboards, base and starting apparatus, there really is no D-C portable type. This new A-C machine, however, in its largest 60-cycle type, weighs about 200 pounds. There are means provided for two men to carry the apparatus to any location, where it may be set up on a bench, or under the bench, or in any position relative or remote from the work. Since the machine has no continually moving parts it will operate in any position, either upside down or on its side.

The machine is designed to meet any power supply. For safety's sake, however, it is not good practice to introduce in the shop any machine with more than 650 volts on the primary. This lowering of the shop voltage is standard practice. The machines can be made for single-phase, two-phase three wire, two-phase four wire, or to operate across the outside wires of the two-phase system, or from a three-phase power supply. The polyphase is necessarily 30 percent heavier than the single-phase machine. For welding, a kilowatt power demand of from 3 to 4½ kilowatts is made; for cutting from 6 to 8 kilowatts. In the case of the two-phase machine, balanced current can be drawn from each of the two phases, by placing the machine across the outside wires, *i. e.*, the 312 volts of a 220-volt circuit.

The wiring is very simple with this new system. The distribution wiring is on the high voltage side, and requires but ordinary wire sizes. For a 400-volt shop, two No. 8 wires are all that are necessary to reach any welding location with a simple plugging-in arrangement. Maintenance is easy because of the absence of moving parts.

The company claims that the qualities inherent in the A-C arc make the cutting of cast iron entirely satisfactory, causing molecular penetration of from ¼ to ⅜ inch, and so distributing the weld and the cast iron that there is no definite hard layer, except for the very outer edges. The surface resulting from the deposition of the metal is smooth. With certain electrodes, ductility and elongation obtained by this new method equal that of mild steel. With boiler plate, test pieces can be welded which will bend flat on themselves, the bend being in the weld. In the twisting test two complete revolutions are possible before tearing.

This new A-C system can be used for either cutting or welding, or both, in one machine. The portability and adaptability of the apparatus should make it particularly valuable for ship construction and repair work.

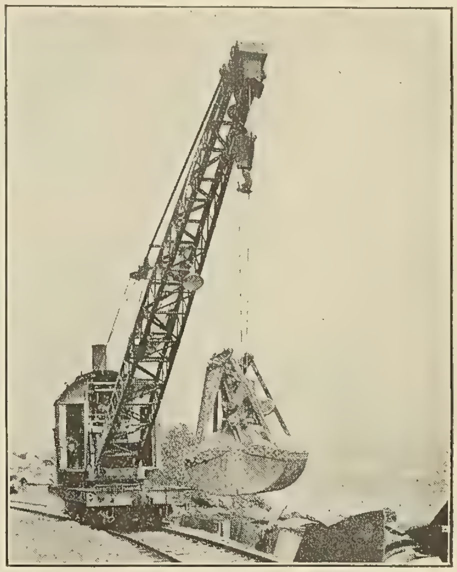
"Blaw" Single-Line Bucket for Coaling Ships

In line with the increased effort to secure efficient handling of coal and cargo at ports and terminals, the placing on the market of the new Blaw-Knox single-line bucket of the clam-shell type is opportune. This device is a simple rope reeved bucket, entirely free from latches, catches and other sliding parts, with a folding arm that locks itself by position only. The locking is absolutely positive, and the bucket cannot possibly open and dump its load, the manufacturers claim, until the arms are pushed over by the operator.

Since the bucket may be hooked on and off the block of any type of crane or derrick with as much ease as a "sling" or other appliance, the equipment is left free for other work when the bucket is not in use. When operating from overhead cranes, these buckets may be used for loading and unloading coal, completely eliminating hand-loaded coal tubs, without installing additional drums or winches; on stiff leg, guy or traveling derricks rehandling of material is possible.

The position of the bucket closed and loaded is shown in the accompanying illustration. It may be dumped by the pull of the operator upon a hand line attached to the tripping lever. This lever is arranged to be operated from the crane cab. It may, however, be operated from the ground if preferred. The complete load may, on the other hand, be dumped without the use of tripping lever or hand line. This action is accomplished by lowering the loaded bucket onto the pile or at the place where the material is to be deposited and slackening the line. Thereupon, the folding arms fall over of their own accord, exactly as if they had been pushed over by a tripping lever. Subsequently, when the bucket is hoisted, the scoops open out and the material is gently deposited. By this arrangement the dumping operation is practically automatic.

The dumping shock is taken up within the bucket itself. The opening motion is arrested by reaction on the line, owing to the position at which the end is secured to the back of the scoops. The shock absorption is complete, and there is no jar on any of the bucket parts; in



Blaw-Knox Single-Line Bucket

fact, the buffers on the hinges do not quite come together until after the bucket is set down again.

This bucket is usually operated with guide rolls in its head—whenever the overhead crane is high enough to get the necessary clearance. It is also employed whenever the bucket is reeved directly to the hoisting drum. Where the clearance is insufficient for operation in this way the guide roll may be dispensed with, as shown in the illustration. The hook is thereby allowed to descend to a point below the head of the bucket. The makers of this new loading device are the Blaw-Knox Company, Pittsburgh, Pa.

Launching Under Unusual Auspices

When the 8,800-ton ship *West Eldara* went down the ways at Skinner & Eddy plant, No. 2, on October 14, Prince Axel of Denmark and his staff were the guests of honor. The boat was christened by a former classmate of the member of the Danish royal family, Mrs. Hakon H. Hammer, wife of the president and general manager of the Universal Shipping Trading Company.

Prince Axel arrived in Seattle but two days previously to the launching. The last details were immediately arranged in his honor. When he mounted the launching platform, the Skinner & Eddy band played the national anthem of Denmark, a tribute, since the workers had mastered the notes over night and played without music.

Ships Loaded in Midstream

Owing to the stress of the times the practice of loading vessels in midstream on the Hudson, or in the harbor, has become quite frequent of late. The unusual sight is now often seen on the Hudson of a large tramp loading direct from a carfloat.

Shipyard Notes

The American Shipbuilding Company, Cleveland, Ohio, is building steel freight ships at Buffalo. Four vessels are now under construction there.

The Charles Ward Engineering Works, Charleston, W. V., will build two tunnel screw towboats and the Marietta Manufacturing Company, Point Pleasant, Ohio, will build two tunnel screw towboats and two stern wheel towboats.

The Patterson-McDonald Shipbuilding Company, Seattle, Wash., is building ten wooden steamships for the Australian Government.

The Wallace Shipbuilding Company, Vancouver, B. C., has received a contract from the Dominion Government to build two steamships of 5,000 tons' capacity and one of 4,300 tons.

The Kingston Steamship Company, Kingston, Ont., will build a 3,750-ton ship for the Dominion Government.

The Port Arthur Shipbuilding Company, Port Arthur, Ont., will build two 3,400-ton steamships for the Dominion Government.

The Victoria Machinery Depot, Victoria, B. C., has received a contract to build two 8,100-ton steel vessels and has been advised that it will receive orders to keep it in operation for at least three years.

Detroit shipyards, employing 8,000 men, have contracts for nearly two years ahead which will be filled, according to officials of both the Great Lakes Engineering Works and the Detroit Shipbuilding Company. The tractor plant of Ford & Son, Dearborn, Mich., has orders for 20,000 tractors on its books, and will take over the $1,000,000 plant built by the Government to increase its production. About 3,000 men will be employed.

The close of the war will bring no abatement in activities at the shipbuilding plant of the New York Shipbuilding Company, Camden, N. J. The company has contracts on hand to keep the plant operating at full capacity on Government vessels, as well as merchant ships for a few years to come. The new yard of the company, now being completed at a cost of about $10,000,000, will be carried out as originally planned, and is expected to be ready for service shortly after the first of the year. This section of the works will give employment to about 4,000 men. Thirteen vessels and eighteen torpedo boats are now on the ways. Two transports also are being constructed. Plans have been prepared for the erection of two one-story additions, 64 by 160 feet and 78 by 90 feet.

Additional buildings are being added to the equipment of the Grant Smith-Porter Shipyards at Aberdeen, Wash. Two steamers of the second contract of eight Ferris types have been completed, and they will be launched in a short time. Scarcity of calkers has delayed the completion of the steamers, which otherwise would have been ready a month ago.

The Welin Marine Equipment Company, 305 Vernon avenue, Long Island City, manufacturing motor boats and other small sea craft, has acquired about 50 by 50 feet adjoining its works for extensions. Plans have been filed for the erection of two additions at Vernon avenue and Hamilton street, to cost about $40,000. It is devoting its operations to the production of boats for the Government.

Government Ship Contracts

The United States Navy Department has asked Congress to authorize a second three-year building program, to provide ten additional super-dreadnaughts, six battle cruisers and 140 smaller vessels, at a cost of $600,000,000. This is in addition to the 156 vessels comprising the first three-year building program authorized in 1916, work on which has been delayed by the war, but which is to be resumed before next July.

The Dachel-Carter Boat Company, Benton Harbor, Mich., has received a Government order to build five ocean-going steel tugs, making necessary enlargements in its plant.

W. G. McAdoo, Director General of Railroads, Washington, D. C., has awarded contracts amounting to $6,170,000 for six towing steamers and forty steam barges, to be used on the Mississippi and Black Warrior Rivers. Four of the steamers are to be of the tunnel screw type, 200 feet long and 40 feet broad, with a draft of 6 feet, while the other two will be 256 feet long, 48 feet broad, with a draft of 10 feet. The barges will have a carrying capacity of 2,000 tons each.

The Hillsborough Shipbuilding Company, J. Wade Tucker, president, Tampa, Fla., will build four wooden barges of 2,500 tons each, for the United States Shipping Board Emergency Fleet Corporation.

The G. M. Standifer Shipbuilding Company, Portland, Ore., has received contracts from the United States Shipping Board Emergency Fleet Corporation to build five more steel steamships, of about 9,000 tons each.

The G. M. Standifer Construction Corporation, Vancouver, Wash., has received contracts from the United States Shipping Board Emergency Fleet Corporation for ten wooden steamships.

L. H. Shattuck, Inc., Portsmouth, N. H., a Government-owned plant, is building wooden ships of the Ferris type for the United States Emergency Fleet Corporation. Five steamers have already been launched. Twelve ways are under construction and six more are to be added.

The American Bridge Company, 30 Church street, New York, will build twenty-five of the barges and the Dravo Contracting Company, Pittsburgh, Pa., will build fifteen of the barges for the United States Railroad Administration, to be used on the Mississippi River.

PERSONAL

ERNEST E. JOHNSON, of the Pacific Steamship Company, sails for Vladivostok on December 15, to open up an office there. Military operations in Siberia have brought a great fillip to American shipping between the American Pacific coast and Vladivostok.

FRANK A. BROWNE, who has been with the Fleet Corporation since its beginning in April, 1917, has resigned his position as general purchasing officer to accept the management of the Mauer plant of the Barber Asphalt Company at Maurer, N. J.

E. V. FRAME, who has been connected with the Chicago office of the Judson Freight Forwarding Company, has assumed charge of the Seattle office of that company.

PROF. COMFORT A. ADAMS, chairman of the committee on electric welding of the Emergency Fleet Corporation, and president of the American Institute of Electrical Engineers, recently addressed the members of the Baltimore Section of the Institute and Engineers' Club on "Application of Electric Welding to Shipbuilding."

THOMAS A. CARR, work's manager of the American International Shipbuilding Corporation's plant at Hog Island, has tendered his resignation, to become effective December 1. Mr. Carr will return to the Boston office of Stone & Webster, to take an important part in new construction work in the near future.

E. G. EKSTROM, general manager, Schaw-Batcher Shipbuilding Company, San Francisco, has resigned and been succeeded by A. L. Becker, former general superintendent of the yards, who in turn is succeeded by O. B. Kibele, formerly marine superintendent of the Union Iron Works, San Francisco.

JOSEPH W. BROOKS and WILLIAM APPLEGARTH are the principal incorporators of the Davis Shipbuilding Company, Cambridge, Md., incorporated, with a capital of $104,000, to operate a local plant.

H. D. MEGARY has been elected to the office of secretary of the Chicago Pneumatic Tool Company since W. B. Seelig has resigned.

A. M. BROWN has been appointed district manager of sales of the Chicago Pneumatic Tool Company, 1740 Market street, Philadelphia, succeeding G. A. Barden, who remains in Philadelphia as sales representative for the company. For some time past Mr. Brown has been located in the New York offices of the company as assistant manager of the compressor sales division.

ROGER C. SULLIVAN was recently appointed a member of the board of directors of the Independent Pneumatic Tool Company. He was elected chairman of the board and a member of the executive committee to fill the vacancies caused by the death of the late John P. Hopkins.

NORMAN P. FARRAR, who for a number of years has been district manager of the Shepard Electric Crane & Hoist Company in Philadelphia territory, has opened a new office in the New Lexington building, Baltimore, Md.

OBITUARY

ALBERT BALLIN, general director of the Hamburg-American Steamship Company, died suddenly, November 9, in Berlin, at the age of 61 years. When the line was taken over by Mr. Ballin in 1887 it was only a small shipping company. Before the outbreak of the war it was accredited as being the greatest single steamship line in the world—500 vessels, with a tonnage built and building, of about 1,500,000, including the two greatest liners in the world, the *Vaterland* and the *Imperator*, in 1914.

CAPT. JEREMIAH B. GREGORY, a retired master mariner, died at Rockland, Me., a few days ago at the age of 85 years. He followed the sea for fifty-seven years, being master for a long time of the bark *Hanson Gregory*, which he lost off the Florida coast in 1870, with three of the crew. He was later superintendent of mining companies in Maine, and chief of police for five years in Hudson, Mass.